NIST Special Publication 1190

Community Resilience Planning Guide for Buildings and Infrastructure Systems

Volume I

Draft for Public Comment

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National Institute of
Standards and Technology
U.S. Department of Commerce

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Executive Summary

Note to reader: This section serves as the Executive Summary for both Volume I and II of the Community Resilience Planning Guide (CRPG) for Buildings and Infrastructure Systems. Volume I and II of the CRPG are intended to be used together.

In the United States, there are always communities working to recover from a disaster. Whether the disaster is due to natural, technological, or human-caused events, most communities eventually will recover. The National Preparedness Goal envisions, "a secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk." The extent of the recovery and ultimate outcome depends upon the nature of the event and the preparedness of the community to include prevention of incidents, mitigation of risk, protection of assets, and pre-event planning for response and recovery. Taken together, these measures will determine the resilience of the community. The Community Resilience Planning Guide (CRPG) for Buildings and Infrastructure Systems supports the national preparedness goal by addressing the role that buildings and infrastructure systems play in assuring the health and vitality of the social and economic fabric of the community. It provides a methodology for local government, as the logical convener, to bring together the relevant stakeholders and incorporate resilience into the long-term community development planning processes. In this way, communities can improve their resilience over time in a cost-effective manner consistent with their long-term development goals. Furthermore, having a plan in place when disaster strikes will enable prepared communities to move quickly to rebuild in a way that makes them better prepared for future events.

Figure ES-1: Downtown Cedar Rapids, Iowa, during the 2008 floods (Source: FEMA 2009)

Communities striving to prepare for and deal with disasters can be overwhelmed by a host of issues, policies, and regulations to address. Each demands time and investment to resolve. Experience shows that communities generally over-estimate their ability to successfully deal with hazard events, as evidenced by the number of Presidential Disaster Declarations each year (FEMA 2011). Transformative planning for resilience is often assigned a low priority unless a recent event focuses community interests. Even then, communities tend to focus on near-term restoration to previous conditions.

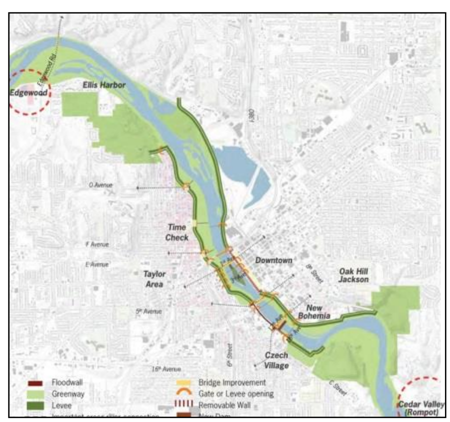

Figure ES-2: Cedar Rapids, Iowa Resilience Plan (Source: Corridor Recovery 2015)

Across the nation, some communities have developed, implemented, and updated plans to improve their resilience. For example, Cedar Rapids, Iowa, developed a well-exercised evacuation plan for dealing with a potential incident at an upstream nuclear power plant. That plan was executed during the flooding of 2008, when the Cedar River crested at well above its predicted 500-year flood event (Figure ES-1). No lives were lost. In the following four months, the City Council and City Manager instituted a community engagement process and developed a Recovery and Reinvestment Plan that is currently being implemented (Figure ES-2). The

Cedar Rapids Plan aims to improve the overall quality of life within the community as well as the community's resilience to flooding events. Communities with a vision for growth, stability, and resilience encourage economic development, as Cedar Rapids has, even as they deal with recovery from a disaster.

The Guide (CRPG) provides a methodology for communities to develop long-term community plans by bringing together all relevant stakeholders, establishing community-level performance goals, and developing and implementing plans to become resilient. The methodology focuses on the role that buildings and infrastructure systems play in assuring that social and economic functions can resume after a hazard event in a manner that does not result in detrimental impacts. If a catastrophic event does occur, the community will have plans in place to rebuild in a thoughtful way to be better prepared for future events, including coordination with state and federal agencies, as outlined in the National Preparedness Goal. The Guide supports the National Preparedness Goal by providing planning guidance at the local level to support achieving the outcome of community resilience.

What is "resilience?"

Presidential Policy Directive (PPD) 8 (PPD-8 2011) defines *resilience* as "the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies." PPD-21 (2013) expanded the definition to include "the ability to prepare for and adapt to changing conditions and to withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents." The term *disaster* refers to "a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources" (National Science and Technology Council 2005). Under these definitions, resilience includes activities already conducted by communities as part of disaster preparedness.

The phrase "prepare for and adapt to changing conditions" refers to situations likely to occur within the lifetime of a facility or infrastructure system. Such conditions may include sea level rise in coastal areas, increased wildfires in areas of drought, or aging effects on infrastructure systems anywhere in the country.

The ability to "withstand and recover rapidly from disruptions" depends on the intensity of the hazard and extent of community disruption. In a resilient community, an event may cause local disruptions that can be tolerated by the community without long-term detrimental effects (e.g., permanent relocation of residents or businesses). If an extreme event occurs, a resilient community likely will have reduced disruption and recovery time.

The Community Resilience Planning Guide: How can it help?

Working with public and private entities at multiple levels, the National Institute of Standards and Technology (NIST) developed this voluntary Community Resilience Planning Guide. NIST developed the Guide under its authorities found at 15 USC §§ 272(b)(10), 272(c)(15), 272(c)(17), 272(c)(22), 278f, and 281a and as a component of the President's Climate Action Plan (EOP 2013). This Guide helps communities incorporate short- and long-term measures to enhance resilience through improvements to the built environment (e.g., buildings and physical infrastructure systems) that the community depends upon to provide services, including those that meet social needs and economic functions. Using the Guide can help communities in the following ways:

- Build on, broaden, and bridge a community's current plans (e.g., economic, emergency preparedness, land use) to *integrate community-level plans* to achieve a resilient community, particularly for the built environment.
- Promote integrated systems-level planning with the *engagement of the entire community*, regardless of the specific hazards a community is most likely to face.
- Guide community leaders to better *define risks, priorities, and pre- and post-event costs*, including the consequences of not taking certain actions.

- Help *prioritize resilience actions* for buildings and infrastructure systems, based on a community's recognition of their importance in supporting its social needs and economic functions, such as health care, schools, businesses, housing, law enforcement, banking, and religious and cultural institutions.

What steps can communities take to use the Guide effectively, and who should be involved?

Planning for resilience can and should build on other community plans already in place. Many pre-disaster plans are not integrated into other community plans, such as the community's comprehensive general plan or the emergency operations plan. A general plan guides a community with long-range goals and objectives for the local government; emergency operations plans prepare communities' responses to emergencies with appropriate and effective methods. Communities need an integrated community-level plan that incorporates steps for disaster preparedness and becoming resilient.

Incorporating the concept of resilience into community development plans involves more than merely adding recovery goals to current community plans. Planning for resilience requires detailed input and development by a broad cross section of leaders and stakeholders, both public and private. Successfully incorporating resilience into community development plans depends on understanding the community's social, political, and economic systems; how they are supported by the built environment; their vulnerability; and how buildings and infrastructure system damage will impact community recovery. For buildings and infrastructure systems that are privately owned and operated, an understanding of their current performance, or planned future improvements, provides key input to the community resilience plan.

This Guide recommends that community resilience be championed by a planning team that provides leadership and engages stakeholders and the community throughout the process. The local government is the logical convener for coordinating public and private interests related to community resilience, as it is responsible for implementing community codes, statutes, and community plans, and can collaborate and coordinate with other public and private entities. Successful community resilience efforts to date have been led by a community official working with a Resilience Team established by the local government that collaborates with other public and private entities. Recommendations are developed by working groups with representatives from public and private entities and subject matter experts. A dedicated community official with supporting staff is in the best position to provide strong and consistent leadership. The Guide can help make a difference in community planning and resilience; the degree depends on the community efforts and commitment. Engaging community stakeholders is vital.

The Guide's methodology involves assessing social institutions and the built environment, with a focus on their role and importance in community recovery. The ways social organizations depend on buildings and infrastructure systems are identified to help support community recovery by establishing recovery sequencing and the degree of functionality needed in the built environment after a hazard event.

To start planning for resilience, communities establish long-term community goals to guide the planning, prioritize resilience activities, and develop implementation strategies. For example, a community may wish to develop improved infrastructure to attract new business; or a community may want to increase social well-being by redeveloping a floodplain to become a community park.

With long-term community goals identified, communities can then identify desired recovery goals for the built environment. Desired performance goals for the built environment are based on meeting the social needs of a community. To determine where shortfalls exist, the anticipated (likely) performance of the community's existing buildings and infrastructure systems also needs to be estimated for the prevailing community hazards. The Threat and Hazard Identification and Risk Assessment (THIRA, FEMA 2013) process, can be used to inform and support this stage of the planning process.

Using three hazard classification levels – routine, expected, and extreme – is recommended to address a range of potential damage, response, and recovery scenarios. Where defined by the codes, the expected event is the design level event (e.g., earthquake, non-tornadic wind loads, etc.). Extreme events may also be defined in the codes for some hazards, such as earthquakes. Where hazard levels are not defined by code, the community may establish a hazard level based on available guidance or frequency of occurrence (e.g., a 10-year mean recurrence interval for a routine event).

A key activity involves identifying the gaps between the desired performance goals and anticipated (likely) performance of the built environment. The gaps in performance guide development of alternative solutions and implementation strategies to meet the long-term community goals and specific desired performance goals for the built environment.

The preferred implementation strategy is reviewed by stakeholders and the community, and then finalized and approved.. Administrative options, such as incorporating resilience principles into other community plans (e.g., land use planning and mutual aid agreements), cost less and can often be implemented more quickly than construction options.

Improving community disaster resilience takes time to implement and additional time for benefits to accrue. Because priorities differ from one community to another, community resilience can be addressed at varying levels of detail that suit the size, capability, and uniqueness of each community. Achieving community resilience requires focus, persistence, and a willingness to assess candidly the interplay of social institutions, governance, economics, and the community's buildings and infrastructure systems.

How does the Guide link a community's social needs to its built environment?

In the context of this Guide, communities are places, designated by geographical boundaries, that function under the jurisdiction of a governance structure, such as a town, city, or county. It is within these places that people live, work, find security, and feel a sense of belonging so they can grow and achieve. All communities have social institutions to meet the needs of individuals and households. They include family, economic, government, health, education, community service, religious, cultural, and media organizations. When considering a community's institutions and the community's reliance on the built environment, it is important to consider the institutions' vulnerabilities and the needs of various segments of the population.

Understanding how a community's social institutions and needs depend on the built environment is key. The need for housing and healthcare is universal. Children need school buildings; neighborhoods need retail districts; businesses need suitable facilities and their supply chains and delivery networks; and everyone needs a transportation network, electricity, fuel, water, wastewater systems, and communication and information access.

The built environment can be significantly damaged after a disaster event, and most people are not prepared to manage on their own. However, only a fraction of the built environment is essential and needs to be functional during and immediately after a disaster event to support social needs, such as emergency response and acute and emergency healthcare. More of the built environment needs to be functional in subsequent days, weeks and months of recovery. One key question is, "When do the buildings and infrastructure systems that support each social institution need to be restored before adversely affecting recovery, or the community's longer-term ability to serve its members?" The Guide helps leaders determine the desired time and sequence for recovery of community functions. The difference between the performance *anticipated* for the built environment in its current state and the *desired* performance is a critical gap to be identified when using the Guide.

What planning steps and key activities contribute to community resilience?

Table ES-1 summarizes six planning steps and associated key activities for achieving community resilience. The key activities are further developed in the indicated chapters of Volume I. The Appendix to Volume I provides an example community plan for Riverbend, USA (a fictional city located in the United States). Volume II presents supporting information and resources for social dimensions of resilience and dependencies between and among buildings and infrastructure systems (e.g., energy systems, transportation systems, communication systems, and water and wastewater systems).

Table ES-1: Planning steps and key activities for community resilience

Planning Steps	Key Activities
1. Form a Collaborative Planning Team (Chapter 2)	• Identify resilience leader for the community • Identify team members • Identify key public and private stakeholders for all phases of planning and implementation
2. Understand the Situation (Chapter 3)	• Social Dimensions – ▪ Identify and characterize functions and dependencies of social institutions, including business, industry, and financial systems, based on individual/social needs met by these institutions and social vulnerabilities ▪ Identify how social functions are supported by the built environment ▪ Identify key contacts and representatives for information, coordination, and decision making
	• Built Environment – ▪ Identify and characterize buildings and infrastructure systems, including condition, location, and dependencies between systems • Identify key contacts and representatives for information, coordination, and decision making • Identify existing plans to be coordinated with the resilience plan
	• Link social functions and supporting built environment • Define clusters of buildings and supporting infrastructure
3. Determine Goals and Objectives (Chapter 4)	• Establish long-term community goals • Establish desired recovery performance goals for the built environment at the community level based on social needs, and dependencies and cascading effects between systems • Define community hazards and levels • Determine anticipated (likely) performance during and after a hazard event to support social functions • Summarize the results
4. Plan Development (Chapter 5)	• Evaluate gaps between the desired and anticipated performance of the built environment to improve community resilience and summarize results • Identify solutions to address gaps that may include administrative and construction options • Prioritize solutions and develop an implementation strategy
5. Plan Preparation, Review, and Approval (Chapter 6)	• Document community plan and implementation strategies • Obtain approval from stakeholders and community • Finalize and approve plan
6. Plan Implementation and Maintenance (Chapter 6)	• Execute approved administrative and construction solutions • Evaluate and update on a periodic basis • Modify short or long-term implementation strategies to achieve performance goals as needed

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1. Introduction

1.1. Overview

The National Preparedness Goal (NPG) states: “Individual and community preparedness is fundamental to our success.” In the NPG, the term ‘community’ refers to groups with common goals, values, or purposes (e.g., local businesses, neighborhood groups). In this Guide, however, the term ‘community’ refers to a place designated by geographical boundaries that functions under the jurisdiction of a governance structure, such as a town, city, or county. It is within these places that people live, work, play, and build their futures. Each community has its own identity based on its location, history, leadership, and available resources. Successful communities provide their members with the means to meet essential needs and pursue their interests and aspirations.

All communities are subject to hazard events and subsequent disruptions. Across the nation, communities experience disruptions from weather events, infrastructure failures, cyber-attacks, technological accidents, sea level rise, and other hazards. Depending on the magnitude and duration of the disruption, communities may experience disruptions ranging from temporary interruptions in services to a permanent loss of businesses and relocation of residents. Hazards become disasters when communities experience extensive disruption in community functions and long periods of recovery.

Community resilience is the ability of a community to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. Activities, such as disaster preparedness (including prevention, protection, mitigation, response, and recovery), and code adoption and enforcement, are key steps, and certainly help, but communities can do more to prepare for and improve their resilience to disasters.

The Community Resilience Planning Guide (CRPG) for Buildings and Infrastructure Systems helps communities determine customized long-term resilience goals and develop plans for their buildings and infrastructure systems. The plans are informed by a community-level assessment of social and economic needs that are supported by the built environment. The built environment includes buildings and infrastructure systems, such as power, communication, water and wastewater, and transportation systems. Buildings and infrastructure systems are vital to community prosperity and health. If these systems fail or are damaged, essential services can be interrupted over a wide geographic area. The Guide helps communities plan how to achieve a rapid, prioritized restoration of functionality.

Resilient communities are more likely to experience minimal or local disruptions in services without long-term detrimental effects for the prevailing hazards that are addressed in community plans. If an extreme event occurs, the extent of disruption and recovery time is reduced with pre-event planning for recovery. Additionally, communities with well-developed resilience plans can use the recovery from a hazard event as an opportunity to improve performance of the community after recovery – to build back better.

Communities can integrate resilience into their long-term community planning process. Long-term planning and implementation of measures to improve resilience support community goals, such as providing an attractive, vibrant place to live for residents and a reliable environment for businesses to locate. A resilient community can also provide day-to-day community benefits by reducing daily disruptions through improved planning, design, and construction practices. Even if it is many years before a hazard event occurs, implementation of the community’s resilience plan will continue to improve the performance of its buildings and infrastructure systems.

The Guide helps communities prioritize improvements to buildings and infrastructure systems based on their role in supporting social institutions and economic functions during recovery, and addresses infrastructure dependencies and cascading effects of system failures. The methodology is organized around the following six planning steps, as outlined in the Comprehensive Preparedness Guide (CPG) 101 (FEMA 2010), and associated key activities. The planning steps are:

1. Form a collaborative planning team
2. Understand the situation
3. Determine goals and objectives
4. Plan development
5. Plan preparation, review, and approval
6. Plan implementation and maintenance

Community planning for resilience of the built environment needs input from all stakeholders, including local government offices for community development, emergency response, social services, public works, and buildings; other government agencies with facilities or infrastructure in the community; public and private owners and operators of buildings and infrastructure systems; local business and industry representatives; and social and economic organizations. Stakeholders may already be working on aspects of planning to achieve resilience, such as land use planning, long-term economic development, mitigation, building inspections, or emergency management. These efforts need to be understood and coordinated.

When all interests and needs are addressed in a comprehensive plan at the community level, a transparent, supportable path forward can emerge with consensus support. Additionally, scarce resources can be allocated based on a community-wide evaluation to prioritize improvements.

1.2. Defining Communities

Communities are highly variable and diverse, with geographic areas and populations ranging from small, rural communities to large, dense, urban communities. Communities have different histories, cultures, social make-up, businesses, industries, and access to and availability of resources.

The Community Capitals Framework (Figure 1-1) describes community assets and resources in terms of capitals: natural, built (physical), financial (economic), human, social, political, and cultural. All of the community capitals are interrelated, giving each community its unique character.

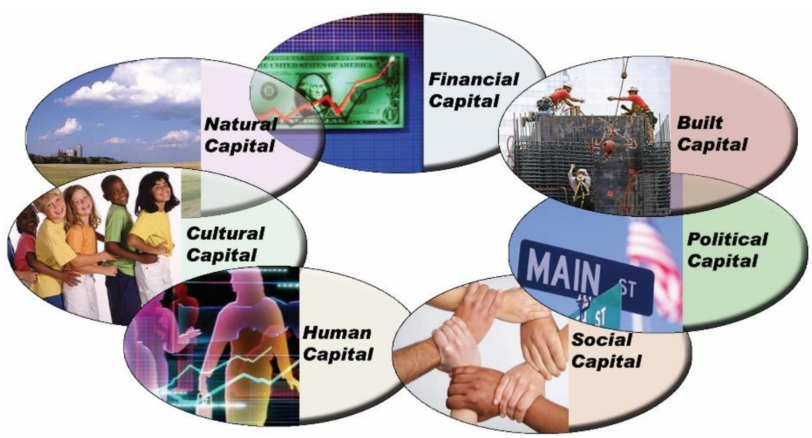

Figure 1-1: The Community Capitals Framework (adapted and redrawn, Flora et al, 2008)

Ritchie and Gill (2011) describe community capitals as:

- ***Natural –*** resources such as air, land, water, minerals, oil, and the overall stability of ecosystems
- ***Built –*** buildings and infrastructure systems within a community
- ***Financial –*** financial savings, income, investments, and available credit at the community-level
- ***Human –*** the knowledge, skills, health, and physical ability of community members
- ***Social –*** social networks, associations, and the trust generated by them among groups and individuals within the community
- ***Political –*** having access to resources and the ability/power to influence their distribution; also, the ability to engage external entities in efforts to achieve goals

- ***Cultural* –** language, symbols, mannerisms, attitudes, competencies, and orientations of local community members/groups.

Knowledge about each type of capital in a community contributes to understanding the community's well-being, sustainable development, and resilience, providing input to disaster preparedness planning and investments.

While all types of capitals are important to each community, this Guide focuses primarily on built capital (i.e., buildings and infrastructure systems), considering how built capital supports other capitals within a community. The needs of community members and social institutions, including government, industry, business, education, and health, help define functional requirements for a community's buildings and infrastructure systems, as illustrated in Figure 1-2. For instance, after a significant event, can residents remain in their homes? Can governments communicate with residents to inform them and support recovery efforts? Can businesses and industries resume operations within a reasonable period? These types of social needs determine the performance expected from a community's buildings and infrastructure systems. However, functional requirements at the community level are often not explicitly established.

Figure 1-2: The social and economic functions of a community define the functional requirements of a community's buildings and infrastructure systems.

A resilience plan offers communities a rational basis for considering alternative measures to meet community goals through improvements to the performance of the built environment. Multiple solutions or stages may be proposed, including temporary solutions to meet immediate needs, as well as long-term recovery steps, such as restoring or improving a building or infrastructure system.

Functional buildings and infrastructure systems are necessary for communities to prosper. When buildings and infrastructure systems are damaged, social services are interrupted, economic losses soar, and precious resources must be re-allocated to repair and rebuild. When damage is extensive, the recovery process can be a significant drain on local residents and their resources, and may be drawn out over years.

1.3. Community Resilience

The term "resilience" is used in many ways. PPD-8 (2011) defines resilience as "the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies." PPD-21 (2013) expanded the definition to include to "the ability to prepare for and adapt to changing conditions and to withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents." The term disaster refers to "a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources" (National Science and Technology Council 2005). Under these definitions, resilience includes activities already conducted by some communities, as a part of disaster preparedness.

In the context of this Guide, the phrase "prepare for and adapt to changing conditions" refers to preparing for conditions that are likely to occur within the lifetime of a facility or infrastructure system, such as a hazard event or physical conditions that may change over time. Depending on location, this preparation may include planning for sea level rise in coastal areas or improving design and performance requirements for a hazard event, such as a hurricane. Changing conditions may also include alterations in our use of infrastructure systems. For example, increased use of communication and information devices may lead to new dependencies between infrastructure systems. Another possible changing condition is aging effects on infrastructure systems. If buildings and infrastructure systems are designed, maintained and operated properly, disruption to community functions should reduce over time, as more of the built environment performs at levels compatible with community resilience goals.

The second part of the definition, "withstand and recover quickly from disruptions," must be examined for the anticipated range of possible hazard events. In a resilient community, a hazard event at the design level (as defined in local codes and standards) may cause local disruptions tolerated by the community without long-term detrimental effects (e.g., permanent relocation of residents or business). If an unanticipated or extreme event occurs, planning and preparation will likely reduce the extent of disruption and recovery time. Additionally, communities that have a well-developed resilience plan are better prepared for the recovery process.

1.4. Community Resilience of the Built Environment

Resilience concept. Figure 1-3 illustrates the concept of resilience for an element of the built environment in terms of 'functionality' versus 'recovery time.' Functionality is a measure of how well a building or infrastructure system operates and meets its intended purpose. Recovery time provides a measure of how long a building or system function is unavailable or operates at reduced capacity. Recovery time also indirectly measures the pre-event condition of the system, performance of the system during the event, and the level of damage sustained.

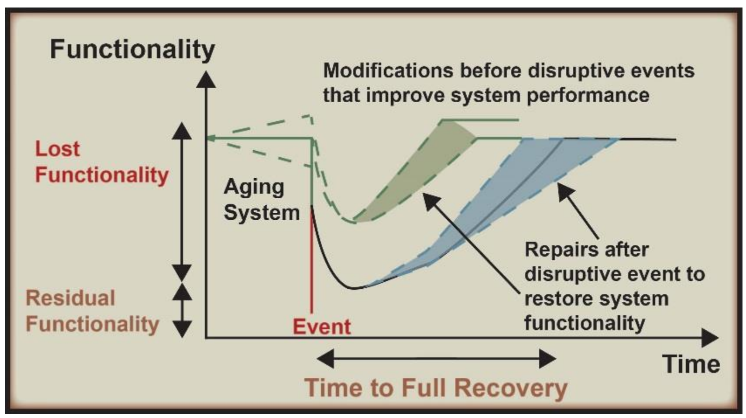

Figure 1-3: Resilience can be expressed simply, in terms of system functionality and the time to recover functionality following a disruptive hazard event (McAllister, 2013).

Planning for resilience can minimize or even eliminate loss of functionality, depending on the available solutions, resources, and priorities. For hazard events, loss of functionality occurs suddenly – on the order of minutes to days – due to physical damage to one or more systems, whereas recovery of functionality may take anywhere from hours to years. Typically, a lesser degree of lost functionality corresponds to more rapid recovery. However, this simple example does not account for dependencies between systems.

Why is community resilience needed? Hazard events can disrupt community functions so extensively that they result in permanent changes. Hurricane Katrina (2005) and Superstorm Sandy (2012) both extensively damaged many communities that are still recovering. However, even for lesser events, communities across our country experience significant damage each year. There were between 45 and 81 Presidential disaster declarations each year, from January 2000 to January 2011, for floods, hurricanes, tornadoes, earthquakes, fire events, and severe storms (FEMA 2011). Many disaster declarations were for hazard events with environmental loads less than current design levels.

Communities currently reduce threats through activities that include adoption and enforcement of codes, standards, and regulations, as well as disaster preparedness activities. These activities are necessary and prudent, but are not enough to make a community resilient. Across the nation, communities continue to experience significant damage and losses, despite robust adoption and enforcement of best practices, regulations, and codes and standards. This is partly because standards and codes for buildings and each infrastructure system are largely developed independently, and they do not address dependencies between systems, nor community-level performance goals. As a result, integrated performance and dependencies between buildings and infrastructure systems cannot be addressed solely through universal adoption of codes and regulations.

Community resilience also requires that the built environment maintain acceptable levels of functionality during and after events. More specifically, communities need to ensure that their built environment operates within a specified period to support recovery. Recovery times are based on the role and importance of each facility or infrastructure system within the community and the extent of disruption that can be tolerated.

This Guide recognizes that communities are primarily composed of existing construction. Buildings and infrastructure systems are built to different codes over time. While degradation or deficiencies in existing construction are cause for significant concern, they also provide an opportunity to develop and implement a new paradigm – community resilience – when planning for and envisioning the future of each community.

1.5. Developing a Plan for Community Resilience

Disruptive events are best addressed by a community resilience plan that includes performance goals for the built environment, and preparedness strategies that include prevention, protection, mitigation, response, and recovery activities. Plans to improve community resilience may include land use policy, temporary measures, and other non-structural approaches. Other aspects of a resilient community – business continuity, and other issues related to human health, safety, and general welfare – may also inform performance goals for the built environment.

To ensure understanding and support by the community and all stakeholders, an active community engagement process needs to be developed and implemented during the entire planning process. A variety of methods are available to inform community members and organizations and solicit their input and questions during the entire process, such as news stories, websites, public meetings, and information booths at community events.

Planning steps and key activities for community resilience. Table 1-1 summarizes the six planning steps and associated key activities for achieving community resilience, briefly described here and further addressed in the indicated chapters.

1. ***Form a collaborative planning team.*** For resilience to be successful, leadership is needed to promote and integrate coordination and outreach activities. The planning team may want to include representatives from local government (e.g., community development, public works, and building departments) and county, state, or federal government agencies with facilities or infrastructure in the region; public and private owners and operators of buildings and infrastructure systems; local business and industry; social organizations; and any other significant community groups. Some groups may already be working on aspects of planning for resilience, such as land use planning, long-term economic development, mitigation, building inspections, or emergency management.

2. ***Understand the situation.*** Understanding the situation involves characterizing both the social dimensions and built environment of a community. Additionally, the dependencies among and between the social services and supporting built environment are identified. Linking buildings and infrastructure systems that support desired social services is an important step in planning to achieve resilience.

<u>Social dimensions.</u> Important social functions and services are identified, as well as key contacts or representatives for obtaining supporting information about systems and decision making. Social dimensions addresses the needs of individuals and social institutions, including government, business, industry, financial institutions, health, education, community service organizations, religious and cultural belief groups, and the media. Examples of social needs of individuals and families are shelter, food, and water after the event; health care including clinics, pharmacies, and doctors' offices; financial security; education opportunities; and employment.

<u>Built environment.</u> Buildings and infrastructure systems that support the community's social functions are also identified, as well as key contacts or representatives for supporting information about physical systems and decision making. Buildings and infrastructure systems are then grouped, or clustered, into subsets that support common functions.

3. ***Determine goals and objectives.*** Long-term community goals guide community plans and implementation of strategies to achieve resilience. For example, a community may want to redevelop a floodplain to become a community park. Community goals also help with prioritization of resilience activities.

   Performance goals for the built environment are based on times to recovery of function. Recovery times are established at two levels: desired performance as a long-term goal and anticipated (likely) performance for existing systems. The desired performance goals should consider the social needs of the community and consider the functions that buildings and infrastructure systems need to provide, as well as dependencies between systems or cascading effects caused by failures. Desired performance goals are set independently of prevailing hazards because they are driven by social needs, not by a hazard event. Once performance goals are set, prevailing hazards and the effects of changing conditions, such as sea level rise or drought, are identified. Then, the anticipated (likely) performance of each group, or cluster, of buildings and infrastructure systems that support social needs after a hazard event is evaluated in terms of its expected time to recovery of function.

   The Guide recommends that the performance of the community be evaluated at three levels for each hazard (i.e., routine, expected, and extreme levels) to help comunities understand performance across a range of hazard levels. By understanding how the built environment will perform and recover over a range of hazard levels, community prioritizations and implementation strategies will be more informed.

4. ***Plan development.*** Initially, a comparison is made of the desired and anticipated performance of the built environment to identify gaps in performance. Then, gaps in desired performance are prioritized based on the community goals and possible solutions are developed. These solutions may include administrative and construction options to mitigate damage and improve recovery of functions across the community.

   An example of an administrative tool is land use planning. For communities that are built out, or are concerned about areas already constructed, possible solution options include: (a) implement land use planning and redevelopment strategies before a hazard event to reduce potential damage and disruption, given sufficient political will and resources and (b) develop plans for alternate land use and redevelopment strategies as part of the recovery process. These options are often part of community development processes, particularly in seismic and flood-prone hazard areas.

   There may be multiple solutions or stages to achieve desired performance, including temporary or short-term solutions to meet immediate needs as well as long-term, permanent solutions. These solutions can then be prioritized, based on meeting the desired performance goals established in the previous step.

5. ***Plan preparation, review and approval.*** A community plan that documents the community goals, desired performance goals, prevailing hazards, and short- and long-term implementation strategies and solutions are prepared and shared with stakeholders and their organizations, as well as with community members, for review and comment. The review process will differ from community to community. After review, the plan is finalized and adopted by the community.

6. ***Plan implementation and maintenance.*** The community then executes the administrative and construction solutions in the approved plan. It will be important for the community to evaluate the plan on a periodic basis, and update as needed. Updates may include modification of the short- or long-term implementation strategies.

Table 1-1: Planning steps for community resilience

Planning Steps	Key Activities
1. Form a Collaborative Planning Team (Chapter 2)	• Identify resilience leader for the community • Identify team members • Identify key public and private stakeholders for all phases of planning and implementation
2. Understand the Situation (Chapter 3)	• Social Dimensions – ▪ Identify and characterize functions and dependencies of social institutions, including business, industry, and financial systems, based on individual/social needs met by these institutions and social vulnerabilities ▪ Identify how social functions are supported by the built environment ▪ Identify key contacts and representatives for information, coordination, and decision making
	• Built Environment – ▪ Identify and characterize buildings and infrastructure systems, including condition, location, and dependencies between systems • Identify key contacts and representatives for information, coordination, and decision making • Identify existing plans to be coordinated with the resilience plan
	• Link social functions and supporting built environment • Define clusters of buildings and supporting infrastructure
3. Determine Goals and Objectives (Chapter 4)	• Establish long-term community goals • Establish desired recovery performance goals for the built environment at the community level based on social needs, and dependencies and cascading effects between systems • Define community hazards and levels • Determine anticipated (likely) performance during and after a hazard event to support social functions • Summarize the results
4. Plan Development (Chapter 5)	• Evaluate gaps between the desired and anticipated performance of the built environment to improve community resilience and summarize results • Identify solutions to address gaps that may include administrative and construction options • Prioritize solutions and develop an implementation strategy
5. Plan Preparation, Review, and Approval (Chapter 6)	• Document community plan and implementation strategies • Obtain approval from stakeholders and community • Finalize and approve plan
6. Plan Implementation and Maintenance (Chapter 6)	• Execute approved administrative and construction solutions • Evaluate and update on a periodic basis • Modify short or long-term implementation strategies to achieve performance goals as needed

1.6. Other Federal Activities Supporting Resilience

1.6.1. National Preparedness Goal

The National Preparedness Goal (NPG 2015) identifies the core capabilities the whole community requires to strengthen the security and resiliency of the United States. The 'whole community' includes individuals, communities, the private and nonprofit sectors, faith-based organizations, and Federal, state, and local governments. The Goal stresses the importance of the whole community in preparedness efforts, uses a risk-based approach to preparedness; and integrates the activities across the five preparedness mission areas through the National Planning Frameworks (NPF 2013): Prevention, Protection, Mitigation, Response, and Recovery. The National Preparedness Goal defines success as:

> *"A secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk."*

These risks may include: natural hazards, such as hurricanes or floods; disease outbreak and other pandemics; technological or accidental hazards, such as a chemical spill or dam failure; and terrorist attacks. The National Preparedness Goal identifies the core capabilities within the five mission areas necessary to achieve a secure and resilient nation. Table 1-2 lists the individual mission areas and their associated core capabilities. The Community Resilience Planning Guide for Buildings and Infrastructure Systems directly supports the Planning core capability. Use of the Guide by local jurisdictions supports all mission areas and indirectly informs a variety of core capabilities. The core capabilities indicated in bold type below directly relate to the Guide content and guidance.

Table 1-2: Core capabilities. The core capabilities indicated in bold type below directly relate to the Guide content and guidance.

<table>
<tr><th>Prevention</th><th>Protection</th><th>Mitigation</th><th>Response</th><th>Recovery</th></tr>
<tr><th colspan="5">Planning</th></tr>
<tr><th colspan="5">Public Information and Warning</th></tr>
<tr><th colspan="5">Operational Coordination</th></tr>
<tr>
<td>• Forensics and Attribution
• Intelligence and Information Sharing
• Interdiction and Disruption
• Screening, Search, and Detection</td>
<td>• Access Control and Identity Verification
• Cybersecurity
• Intelligence and Information Sharing
• Interdiction and Disruption
• Physical Protective Measures
• Risk Management for Protection Programs and Activities
• Screening, Search, and Detection
• Supply Chain Integrity and Security</td>
<td>• Community Resilience
• Long-term Vulnerability Reduction
• Risk and Disaster Resilience Assessment
• Threats and Hazard Identification</td>
<td>• Critical Transportation
• Environmental Response/Health and Safety
• Fatality Management Services
• Infrastructure Systems
• Mass Care Services
• Mass Search and Rescue Operations
• On-scene Security and Protection
• Operational Communications
• Public and Private Services and Resources
• Public Health and Medical Services
• Situational Assessment</td>
<td>• Economic Recovery
• Health and Social Services
• Housing
• Infrastructure Systems
• Natural and Cultural Resources</td>
</tr>
</table>

1.6.2. National Preparedness System

The National Preparedness System is the instrument the Nation employs to build, sustain, and deliver those core capabilities and achieve the goal of a secure and resilient Nation. The guidance, programs, processes, and systems that support each component of the National Preparedness System enable a collaborative, whole community approach to national preparedness that engages individuals, families, communities, private and nonprofit sectors, faith-based organizations, and all levels of government. The Guide is a tool that supports the Preparedness System by building and sustaining capabilities through multi-year resilience planning.

1.6.3. National Infrastructure Protection Plan

The National Infrastructure Protection Plan (NIPP) outlines how government and private sector owners and operators in the critical infrastructure community collaborate to manage risk and to advance security and resilience outcomes. The NIPP encourages partners to identify critical functions and resources that impact their businesses and communities to support preparedness planning and capability development. The National Infrastructure Protection Plan addresses 16 critical infrastructure sectors, as identified in PPD-21 and presented in Table 1-3. The Guide highlights several key sectors in the built environment and the guidance contained within the Guide is applicable across the critical sectors. Volume II of the Guide outlines several specific infrastructure systems (i.e., Energy, Communications, Water and Wastewater Systems, Transportation), identifies applicable standards and codes, and lists implementation strategies for community resilience plans. Chapter 11 (Buildings), includes generic guidance applicable to many other building dependent infrastructure sectors.

Table 1-3: Critical Infrastructure Sectors

Critical Infrastructure Sectors
• Chemical
• Commercial Facilities
• Communications
• Critical Manufacturing
• Dams
• Defense Industrial Base
• Emergency Services
• Energy
• Financial Services
• Food and Agriculture
• Government Facilities
• Healthcare and Public Health
• Information Technology
• Nuclear Reactors, Materials, and Waste
• Transportation Systems
• Water and Wastewater Systems

1.6.4. Disaster Mitigation Assessment

Nearly 24,000 communities, representing 80% of the people in the United States, have developed mitigation plans in accordance with FEMA Disaster Mitigation Assessment guidance, based on the Disaster Mitigation Act of 2000 (DMA 2000). As mitigation is a component of resilience, these communities are taking substantive steps toward planning for resilience. A planning process that includes a detailed consideration of the built environment as outlined in the Guide and incorporates ongoing mitigation planning provides a comprehensive understanding of community resilience.

For existing community mitigation planning structures, expanding the scope to resilience is the next logical step. Those already involved in mitigation activities have roles and responsibilities similar to those needed for resilience. The mitigation planning process emphasizes public participation in vetting mitigation strategies with targets, actions and priorities.

1.6.5. Threat and Hazard Identification and Risk Assessment

The Threat and Hazard Identification and Risk Assessment (THIRA), outlined in Comprehensive Preparedness Guide 201, Second Edition (FEMA 2013), is a risk assessment process that helps communities understand their risks and capability requirements to address anticipated and unanticipated risks. The THIRA process helps communities map their risks to the core capabilities identified in the National Preparedness Goal. The outputs of this process inform a variety of emergency management efforts, including emergency operations planning and mutual aid agreements. Results of the THIRA process can inform preparedness activities, including mitigation opportunities that may reduce the amount of resources required in the future. Through the THIRA process, communities can identify opportunities to employ mitigation plans, projects, and insurance to reduce the loss of life and damage to property. The THIRA process can be used as part of Step 2 of the planning process outlined in the Guide, Understand the Situation.

1.7. Other Resilience Activities

There are a number of resilience initiatives and activities at regional, national, and international levels, including assessment methodologies that engage stakeholders in a variety of ways.

Resilience efforts (or activities) focused on the United States include the SPUR (2009) Framework, Baseline Resilience Indicators for Communities (BRIC) (Cutter et al 2014), the Community and Regional Resilience Institute's (CARRI) Community Resilience System (2013), the Oregon Resilience Plan (2013), NOAA's Coastal Resilience Index (2010**)**, and the Communities Advancing Resilience Toolkit (CART) (Pfefferbaum et al 2013). International initiatives include the United Nations International Strategy for Disaster Reduction (UNIDSR 2014) Resilience Scorecard and the Rockefeller Foundation's 100 Resilient Cities initiative (Rockefeller 2014).

Some approaches propose qualitative methodologies while others use quantitative approaches presenting the outcomes often in the form of scorecards or dashboards by measuring key resilience aspects. Such visual representations are often desirable as they can provide a direct and simple way of presenting the information both for experts in the field or for decision makers. In general, most of these methodologies focus on social issues, and in some cases, the focus is on one particular social service or system.

Broadly speaking, each of the listed initiatives provides a set of dimensions or categories of community disaster resilience and, in many cases, includes a list of indicators or variables for each dimension. In cases where the methodologies involve the engagement of community stakeholders, process-oriented guidelines for implementation are included. For methodologies that are heavily quantitative—typically involving readily available data —details are provided about strategies for data analysis and modeling.

NIST found that most of these resilience initiatives have minimal integration of infrastructure systems and how they support social and economic needs, and do not address dependencies between and among the social and built environments. This Guide is designed to address this issue. If your community is already engaged in resilience planning, this Guide can be used to enhance these efforts.

1.8. Guide Scope and Limitations

The Guide helps communities determine customized long-term goals and develop implementation strategies for improving the resilience of their buildings and infrastructure systems. While the plans are informed by a community-level assessment of social and economic needs, the focus of this process document (Volume I) and supporting material (Volume II) is on buildings and infrastructure systems that exist within a community. With this focus in mind, there are other important aspects of community resilience that fall outside the scope of this Guide, including:

- Roles and responsibilities of federal, state, and local departments/agencies addressed through the National Preparedness Goal
- Social, political and economic solutions or strategies to achieve a more resilient community
  - Methods of engaging and informing stakeholders and community members
  - Political processes that support development and adoption of community plans and laws, statutes, and ordinances
  - Methods of obtaining financial resources and evaluating investment options to support community resilience strategies
- Specifics on community services that are essential for community response and recovery, for example, banking and finance. Community services are discussed only to the extent they are supported by the built environment.
- Specifics on vulnerable populations and the ways in which they might be affected by a disaster event
- Natural resources and the environment (natural capital), and the linkages with the built environment (built and physical capital), as well as other capitals (i.e., financial or economic, human, social, political, and cultural)

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2. Form a Collaborative Planning Team

A robust community resilience plan represents the interest of all stakeholders in the community, both public and private. Such a plan will benefit from collaborative arrangements between community leaders, public and private stakeholders, and interested community members. Engagement by community stakeholders is vital.

The planning team may include representatives from the local government, such as community development, public works, and building departments; public and private owners and operators of buildings and infrastructure systems; local business and industry representatives; representatives of the community's social institutions (e.g., community organizations, nongovernmental organizations, business/industry groups, health, education, etc.); and any other stakeholders or interested community groups. As shown in Figure 2-1, while the planning team is focused at the community level, stakeholders in the planning process may range from individuals and families to national stakeholders, depending on the community's resources and characteristics. For instance, roads and bridges are typically addressed at the county and state level, energy systems may range from the community to the regional level, and mitigation support may be provided at the state or national level.

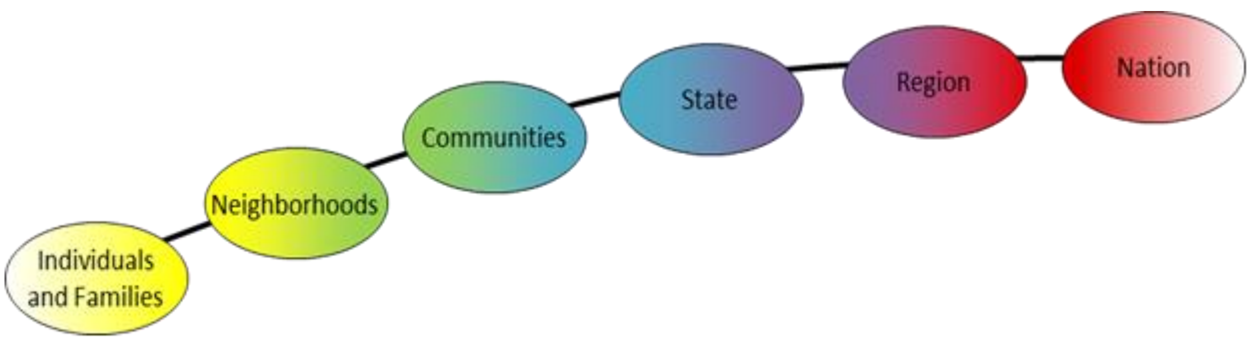


Figure 2-1: Levels of government and organization (adapted and redrawn, John Plodinec [CARRI 2013]).

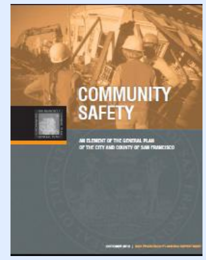
Because most of the built environment is owned by both public and private entities and because of the holistic nature of the plan, a public-private partnership approach is essential. Successful planning efforts to date have been led by a community official working with a planning team, which develops recommendations through working groups of stakeholders and subject matter experts.

As community resilience is an ongoing, long-term process, leadership through a dedicated community official is needed to provide continuity, elevate the importance of resilience, provide authority for convening stakeholders, and engage public support. The recent designation of a Chief Resilience Officer in many cities is an illustration of the type of leadership needed. Strong support and endorsement from elected officials ensures that the planning process will have visibility, and is more likely to encourage community engagement through stakeholder participation.

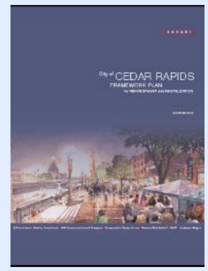
Local champions who are highly connected and engaged with neighborhood, business, or community groups, or actively engaged in other community-based activities are also important. Local champions advocate for support and participation from community stakeholders, and can help reach and develop understanding with groups representing the diverse views and experiences within the community and with the voters and public at large. They can be quite influential in rallying the community around planning for resilience.

Community engagement is an important aspect of a community's social capital. At the most basic level, social capital is the social community assets and resources that facilitate information sharing, provides a conduit for social support, and enhances the capacity for collective action. Social capital is represented by social networks, associations, and the reciprocity and trust generated by them among individuals, groups, and communities. Similar to cultural capital, social capital reflects the convergence of shared values in a community. It is especially valuable because it enhances a community's ability to work toward collective goals—many of which include an increase in other forms of capital.

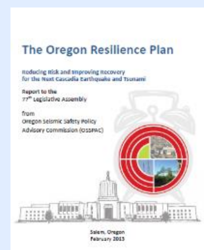
Resilient San Francisco. Resilient SF was organized within the Mayor's office, solicited support from the Harvard Kennedy School, a citizen's advisory group formed by the Chief Building Inspector, and accepted guidance from a self-appointed planning group from the San Francisco Planning and Urban Research Association (SPUR 2009). SPUR contributed a Resilient City Plan to the advisory group that developed a Community Action Plan for Seismic Safety that lead to the creation of the Earthquake Safety Improvement Program and a 30-year program for achieving resilience within the city's privately owned program. This program, in conjunction with the City's Capital Planning process and Lifelines Council, established a holistic effort toward resilience. It is now overseen by a Chief Resilience Officer and the Earthquake Safety Implementation Program Office, which is a part of the City's Executive Branch.



Cedar Rapids, Iowa. The Cedar Rapids Framework Plan for Reinvestment and Revitalization (Corridor Recovery 2015) was initiated and led by the City Council following the 2008 Floods, and was an expansion of their ongoing City wide planning efforts. Early in the process, three open houses for the "River Corridor Redevelopment Plan" were organized to receive feedback for the residents on the preliminary community analysis. The planning process included all the related City departments and received input from a Recovery and Reinvestment Coordinating team, various coordinating groups, committees, and organizations, representatives from the medical community, the railroads, and other industrial stakeholders. The plan is being implemented and has already generated significant improvements in the City.



Oregon Resilience Plan. The Oregon Plan was initiated by the Oregon State Legislature and lead by the Oregon Seismic Safety Policy Advisory Commission (Oregon 2013). The commission includes 19 appointees of the Governor who represent the various disciplines related to seismic safety policy including emergency managers, transportation, land conservation, housing and buildings, architects, engineers, and stakeholders from businesses, schools, the Port of Portland, and the construction industry. Planning work was organized around a number of task groups to address the seismic and tsunami hazards, business and workforce continuity, coastal communities, critical and essential buildings, and transportation, energy, water and waste water systems. The report was accepted by the State legislature in 2014 as a framework for communities to implement.



Social capital has the potential to contribute to resilience by enhancing sense of belonging and strengthening bonds between individuals and groups within communities (see Chapter 9, Volume II). This potential is increased when civic engagement involves multiple and diverse sets of stakeholders. Community engagement facilitates understanding by the community, raises awareness of resilience activities, and can foster buy-in and support for important resilience projects, bond issues, and legislation.

In the short-term, understanding of and support for resilience efforts can promote increased perceptions of safety and security within the community. In the long-term, these perceptions can lead to stronger community identity and a higher quality of life.

The planning team and the related working groups will vary in size and breadth depending on the community. Planning team members from agencies with authority to plan, regulate development, and make final recommendations and decisions, as required by resilience activities, can provide valuable input to the planning process and knowledge about execution for implementation strategies. Stakeholders are affected by the decisions and may join working groups along with subject matter experts to develop specific recommendations for consideration by the planning team.

Examples of those that may be included on the planning team or included in the stakeholder working groups are listed below.

- ***Elected officials***
  - ***The Office of the Chief Executive (e.g., Mayor)*** provides leadership, encourages collaboration between departments, and serves as the link to the stakeholders in organizing, compiling, and vetting the plan throughout the community. The office also serves as the point of contact for interactions with neighboring communities within the region and the State. A Chief Resilience Officer or other leader within the office should be considered for leading the effort.
  - ***City Council or Board of Supervisors*** represents the diversity of community opinion, adopts the needed plans, and enacts legislation for needed mandatory mitigation efforts.

- ***Local Government***
  - The ***Building Department*** identifies appropriate codes and standards for adoption; reviews building plans and provides inspection services, as needed, to assure proper construction; and provides post-event inspection services aimed at restoring functionality as soon as possible. The department may also develop and maintain a geographic information system (GIS)-based mapping database of all community physical infrastructure, social institutions, and relationships between the two.
  - The ***Department of Public Works*** is responsible for publicly owned buildings, roads, and infrastructure, and identifies emergency response and recovery routes.
  - ***Fire departments/districts*** are responsible for codes and enforcement of construction standards related to fire safety and brings expertise related to urban fires, wildfires, and fire following hazard events.
  - ***Parks and Recreation*** identifies open spaces available for emergency or interim use for housing and other neighborhood functions.
  - The ***Public Utilities Commission*** is responsible for overseeing private and public owned utility systems, setting rates and service levels, and assisting in developing recovery goals.
  - The ***Planning Department*** identifies pre-event land use and mitigation opportunities and post-event recovery opportunities that will improve the city's layout and reduce vulnerabilities through repair and reconstruction projects and future development.
  - The ***Emergency Operations Department*** identifies what is needed from the physical infrastructure to streamline response and recovery of the social institutions within the community.
  - ***Boards of Education, Trustees and Regents*** who represent all levels of education will clarify the system's tolerance for disruptions and ability to operate under temporary conditions.
  - The ***Human Services Department (or equivalent)*** identifies the services vital to support community member needs, including senior, youth, people with disabilities, and family services and programs (including childcare).

- ***Business and Service Professionals***
  - ***Chambers of Commerce*** represent business and industry interests and include many of the community's business leaders who will bring a clear perspective on the economic impact of potential disasters and also the impact of resilience plans.
  - ***Community business districts*** represent the large and small businesses that support the neighborhoods and play a key role in community recovery.
  - ***Building owners, and managers*** provide the individual building owners' perspective on resilience and recovery in terms of their needs for labor, buildings, utilities, and other infrastructure systems, as well as how their needs influence the performance levels selected.
  - ***Utility providers including power, communications, water, wastewater, and transportation,*** are key to rapid recovery of functionality, and will bring perspective on the changes needed in current regulations and rate limitations. Collaboration between providers is essential to understand the community needs and priorities for recovery, as well as the dependencies they share.

  - ***Healthcare providers*** including public health officials, providers of acute, sub-acute, rehabilitation, mental health, behavioral and end of life care, who will bring clarity to the services that are being provided before and those that are needed immediately after a significant event throughout the recovery period.
  - ***Architects and urban planners*** bring a vision for an improved community that supports transit, housing, integrated neighborhoods, and improved quality of life.
  - ***Engineers*** determine the design and performance capabilities for the built environment and assist in developing suitable standards and guidelines. They can help establish desired performance goals and the likely performance anticipated for the existing built environment.
  - ***Construction professionals*** provide perspective on the feasibility and consequences of changing building design and construction practices, and also provide perspective from their clean up and reconstruction activities after a disaster.
  - ***Media*** plays a key role in disseminating important information about the response and recovery efforts, as well as the resilience process and progress, to community members.

- ***Community and Volunteer Organizations***
  - A ***Nongovernment Organizations*** (NGO) is any non-profit, voluntary groups that is organized on a local, national or international level and is task-oriented. NGOs perform a variety of service and humanitarian functions, bring community members' concerns to governments, advocate and monitor policies and encourage political participation through provision of information. Within the Community Service social institution (see Chapter 2), NGOs provide support to other social institutions, especially those that provide services to vulnerable and at-risk populations.
  - ***National Voluntary Organizations Active in Disaster*** (VOAD) are nonprofit, nonpartisan, membership-based organizations that help to build resiliency in communities nationwide. These serve as the forum where organizations share knowledge and resources throughout the disaster preparedness cycle to help survivors and their communities.
  - ***Community Service Organizations (CSO) and religious/cultural groups*** are volunteer, membership-based groups that provide services to the community's members and have a role in the post-disaster environment.

Guidance related to building a planning team is well documented in the FEMA Local Mitigation Planning Handbook (FEMA 2013). Many departments, businesses, and groups may already be working on aspects of planning to achieve resilience, such as land use planning, long-term economic development, mitigation, building inspections, or emergency management.

2.1. References

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3. Understand the Situation

The built environment is an essential part of community resilience. Social institutions, including family/kinship, education, health, government, economy, media, other community-based organizations, rely on buildings and infrastructure systems at all times – before, during, and after a hazard event occurs. Building clusters (buildings grouped by similar function) and infrastructure systems must be functional to support restoration of neighborhoods, care for vulnerable populations, and restore the community's economy.

A comprehensive understanding of a community includes identifying:

- Community members and how social institutions meet their needs prior to hazard events and during recovery
- Buildings and infrastructure systems that support the functions of these social institutions

In this planning step, the planning team characterizes community's social dimensions and built environment, and identifies links between them.

3.1. Identify and Characterize the Social Dimensions

The social needs of a community provide the basis for establishing performance goals for the built environment. Understanding a community's social needs involves identifying and characterizing its community members, their needs, and the social institutions that exist to meet those needs. Characterizing the social community includes four sub-steps:

1. Characterize community members and their present and future needs, including the community population demographics, economic indicators, social vulnerabilities, and the needs of community members. Additionally, long-term growth needs of the community should be considered.
2. Identify social institutions/systems within the community, including their functions, the needs they meet, and any gaps in institution/organizational capacity that can be improved by changes to the built environment.
3. Identify dependencies among and within social institutions.
4. Identify key social and economic community metrics, such as methods of tracking the impact of community planning and improvements.

Characterize the population. Characterizing the population involves taking stock of the community's demographics and economic indicators, identifying social assets and vulnerabilities within the population, and recognizing the needs of different groups in the community. A generalized hierarchy of human needs within a community, where the most basic need is survival, appears in Chapter 9 (Volume II). These generalized needs will require further development by communities, once they have characterized their social community. Although all needs are important, some needs are more urgent or time sensitive than others—a concept that is particularly salient in the context of resilience.

Additionally, because resilience involves long-term planning and decision-making for changes to the built environment, ways in which community demographics, vulnerabilities, and specific local needs may change over time should be considered.

Identify social institutions. Social institutions typical to a community can include family/kinship, economics, government, health, education, community service organizations, religious and cultural organizations (or other organizations that support belief systems), and the media. Each social institution serves a purpose that meets the needs of its community members or various groups within the community. Institutions are organized in different ways, often through offering a variety of services, to serve community needs. It will be important for communities, during this step, to identify the various types of social institutions that exist and to understand how these social institutions are organized within the community (i.e., identification of the services they provide and their dependencies) to support needs of community members.

At this stage, the planning team can begin to identify gaps in capacity within the social institutions. These are situations in which the social institutions and services are unable to meet all the needs of community members, or would likely be unable to maintain services after a hazard event. It will be important to identify any gaps in social capacity that can be reduced by a change/improvement to the built environment. For example, the community would benefit if public housing were relocated outside a flood zone.

Links between social institutions and their services to social needs are determined to identify strengths and weaknesses. For more urgent needs, social goals or requirements during recovery can be further developed. For example, the community may identify critical care services offered by the health institution or emergency response functions offered by the government as functions that meet the most urgent needs during recovery, and thus, the capacity of these institutions to function at all times (especially during recovery) needs to be understood.

Identify dependencies. Given that social institutions are linked with each other in many ways, a disruption in the built environment that affects one social institution may also affect others. Therefore, dependencies among and within social institutions are identified to determine which functions are most critical during recovery. Because each community is different, it is impossible to provide an exhaustive list of all of the ways in which social institutions rely on one another. Instead, Chapter 9 (Volume II) provides examples of such dependencies for communities to consider.

Identify metrics. Communities may identify methods (or measures or metrics) to track the progress of social and economic aspects of community resilience and improvement activities. Questions that community metrics may help to answer are:

- How resilient are the social and economic institutions in your community?
- Will my community's decisions and investments improve resilience? If so, how significant of a difference will be made?

Social and economic metrics can help community decision-makers understand the economic and social implications of community decisions for planning, siting, design, construction, operation, protection, maintenance, repair, and restoration of the built environment. Social and economic-based resilience metrics can be quantitative or descriptive in nature. The result can be presented as an overall resilience-related score or as a set of separately reported scores across a broad spectrum of physical, economic, and social dimensions. Examples of resilience metrics for social and economic systems and existing community resilience assessment methodologies are provided in Chapter 16 (Volume II).

In understanding the community, the planning team also characterizes the built environment, as discussed in the following section. Characterizing the social dimensions and the built environment may occur in parallel.

3.2. Characterize the Built Environment

Characterizing the built environment includes identifying key attributes and dependencies for existing buildings and infrastructure systems within the community. Community building and public works departments and utilities may have much of the needed information available through their GIS applications or other databases.

Data and information that will help characterize the current condition of the built environment include the owner, location(s), current use, age, construction types, zoning, maintenance and upgrades, and applicable codes, standards, and regulations, both at the time of design and for current performance. Information about dependence on other systems, subsystems, or branches of systems, will help build an understanding of how the built environment is expected to perform if one of the systems, or a branch of the system, stops providing services.

Another important piece of information is the geographic location of these structure throughout the community. GIS-based maps can help communities understand whether their buildings or infrastructure systems are located in higher-risk areas. For instance, many communities were established before flood zones were mapped, and have buildings and infrastructure systems located in flood plains. Other communities have buildings and infrastructure systems located near seismic faults that may not perform well if a significant seismic event occurs. Or there may have been a period of rapid growth that resulted in exceeding infrastructure system capacity, or development that did not have adequate adoption or enforcement of local codes and regulations.

Buildings. Buildings can be characterized individually and as groups, or clusters. Characterizing a community's building stock involves identifying the number of buildings within the community, by building type, occupancy, and use. Additional information that is important to establishing performance and recovery times may include construction types that may not perform well, such as unreinforced masonry, soft story construction in seismic zones, or a lack of positive ties (e.g., hurricane clips) to avoid wind uplift damage. See Chapter 11 in Volume II for additional considerations in characterizing the building stock.

Transportation. In addition to roads and bridges in each community, transportation systems may include rail systems, airports, coastal or riverine ports, pipelines, waterways, or trucking hubs. Many communities maintain their local roads and rely on other owners and operators to maintain other transportations systems. For instance, counties and states own and maintain most of the highways, airports and shipping ports are managed by regional authorities, and most rail lines are independently owned and operated. Information and data on the transportation infrastructure and their dependencies will support development of performance and recovery issues, such as anticipated usage (e.g., traffic loads on evacuation routes) and redundancy options for meeting transport needs (e.g., temporary energy sources and alternate routes). For example, transportation systems that support emergency response, evacuation routes, supply routes for restoration, and building clusters for recovery may have different roles in each recovery phase. See Chapter 12 in Volume II for additional considerations in characterizing transportation systems.

Energy. Energy systems include electric power and fuel systems. Electric power systems include power generation, transmission, and distribution, though it is the distribution systems that most communities have located within their boundaries. There are many 'models' for electric power systems that range from municipally operated and owned systems to private regional systems. Coordination with owners and operators of energy systems to obtain information that supports the performance and recovery plans for community resilience is strongly encouraged. For many communities, understanding the sequence of power restoration is key to planning the community recovery. Fuel supply mechanisms and distribution systems also need to be characterized. Fuel may be supplied by tankers, trucks, or pipelines. The total amount of fuel required by the community may change during recovery if temporary power sources, such as generators, are used. See Chapter 13 in Volume II for additional considerations in characterizing energy systems.

Communication. Communication services include internet, cellular, and phone services. Communication companies are privately owned and there are multiple providers of these services in many communities. Smaller, regional companies may share infrastructure with a national company. Communication infrastructure includes central offices and other equipment-based facilities to direct and process calls, data and cables, cell towers, and similar systems to transmit and distribute the calls and data. Similar to electric power, most communities have distribution systems within their boundaries. Coordination with owners and operators of communication systems to obtain information that supports their performance and recovery plans for community resilience is strongly encouraged. See Chapter 14 in Volume II for additional considerations in characterizing communication systems.

Water and wastewater. Water systems are supplied by either surface or ground water. Water systems include treatment plants and pipelines for distribution. Wastewater systems collect wastewater through separate pipelines and pump stations to a wastewater treatment plant, and are located near the body of water used for discharge. Both of these systems are typically owned and operated at the local level, either by communities or counties. Information on system age, maintenance, location, and service area is readily available in many communities. Many water systems are older and may need replacement; the performance of older buried systems may deserve additional planning options for recovery. Water sources may be local, or they may be shared with other communities. Shared water sources may require collaboration with other nearby communities for daily water supplies and recovery plans. See Chapter 15 in Volume II for additional considerations in characterizing water and wastewater systems.

Dependencies. An understanding of building and infrastructure system dependencies can be overlooked in recovery planning. Planning for resilience at the community level allows consideration of dependencies and how to minimize their negative impact during recovery of functions. There are multiple dimensions of dependency: internal and external, time, space, and source dependencies. Due to the complex nature of infrastructure system interactions, these dimensions of dependency are not completely decoupled. Interactions within and between infrastructure systems can depend on a number of factors. Traditionally, dependencies consider the physical and functional relationship between different systems (i.e., drinking water systems require electricity to operate pumps). See Chapter 10 in Volume II for additional considerations in characterizing system dependencies.

3.3. Link Social Dimensions and the Built Environment

Once the social dimensions and built environment are characterized, communities can identify links between the social institutions (and the services they provide) and the buildings and infrastructure systems for both day-to-day operations and the recovery process. When linking social institutions with the built environment, it is important to note that some institutions rely more heavily on the built environment than others. An example of this is the health institution, where emergency services are often difficult to provide outside of hospitals or other buildings on a longer-term basis, since specialized equipment often relies on power and/or water.

In this step, a community identifies the ways in which the built environment supports each social institution. This involves understanding the purpose of the built environment for each institution, how that purpose is actualized, and the direct and indirect consequences that may occur—to individuals, groups, and the community—when the built environment is degraded in function. Chapter 9 (Volume II) provides several examples of linkages between social institutions and the built environment, specifically buildings, transportation, water/wastewater, power/energy, and communication systems both under normal circumstances as well as after a hazard event.

By considering these linkages, the planning team can begin to identify building clusters and infrastructure systems that support those clusters. The term ‘cluster’ refers to a set of buildings and supporting infrastructure systems that serve a common function such as housing, healthcare, retail, etc. For instance, building performance during a hazard, and needs for restoration, can be considered for individual buildings that provide a critical service and for clusters of housing or commercial facilities. Clusters are not necessarily geographically co-located, and may be distributed throughout the community. Additionally, the service or function served by the cluster before the hazard event may change during recovery. For example, school facilities are often used as emergency housing for a few weeks after an event.

4. Determine Goals and Objectives

4.1. Goals for Community Resilience

Community planning for resilience is based on long-term goals to guide planning and implementation. Each community will define its own long-term planning horizon, depending on its existing infrastructure, plans for improvements, and resources. With regards to the built environment, renewal or replacement of existing buildings and infrastructure often takes place over a nominal range of 30 to 100 years, depending on the building or infrastructure system use and type of construction.

Community goals help a diverse set of stakeholders develop strategies for achieving the stated goals and prioritize supporting administrative and construction solutions. Community goals, such as minimizing disruptions to daily life, attracting new business and residents, and improving recovery after a hazard event will help define the role of the built environment and associated performance goals. The community goals can guide the setting of specific goals for the desired performance of buildings and infrastructure systems, based on their role in the community.

The desired recovery times are the selected performance goals. They are at the heart of community plans and long-term strategies for resilience. The performance goals should consider the needs of the social institutions as well as dependencies between building clusters and supporting infrastructure systems. Including desired performance goals versus anticipated (likely) performance of the existing built environment to hazard events, and expected recovery sequences, time, and costs provides a complete basis for communities to understand gaps in performance, prioritize improvements, and allocate resources. To determine where shortfalls exist, the anticipated (likely) performance of the community’s existing buildings and infrastructure systems also needs to be estimated for the prevailing community hazards. The Guide recommends that the performance of the community be evaluated at three levels – routine, expected, and extreme – for each hazard to help communities understand performance across a reasonable range of expected hazard levels. By understanding how the built environment will perform and recover over a range of hazard levels, community prioritization will be more informed.

4.1.1. Establish Long-Term Community Goals

Long-term community goals guide the planning, prioritization, and implementation process. The goals are high level statements of outcomes that are desired to improve the community. Examples include:

- Define a state of improved resilience for infrastructure systems to improve reliability and community functions
- Improve or add redundancy to a transportation route that is vulnerable to damage and minimize travel impacts on residents and supply impacts on businesses
- Revitalize an existing area through improvements that make the community more resilient

Agreement on priority long-term community goals will guide decisions and resource allocations.

4.1.2. Establish Desired Performance Goals

To recognize common functions served by groups of buildings or infrastructure systems, the term ‘cluster’ is used to denote buildings or systems with a common function. However, a cluster does not necessarily mean that the buildings or infrastructure systems are geographically co-located. Examples are residential housing, schools, or healthcare facilities and supporting infrastructure. These groups or clusters serve the community social institutions and needs and typically have similar performance goals.

Desired performance goals depend on: (1) an acceptable level of damage that occurs for a particular hazard level (performance level) and (2) the corresponding recovery time to restore full functionality. Performance levels address life safety and post-event functionality. Recovery times help prioritize repair and reconstruction efforts. Additionally, performance goals should consider the role of a facility or system on local, regional, and possibly national and international needs. For instance, if a production plant in a community is the national supplier for a particular product, the impact of damage to that plant extends well beyond the community.

Estimating when a building cluster needs to be functional during recovery includes consideration of post-event social and economic needs of the community, as well as the dependencies between building clusters and supporting infrastructure systems.

Setting desired performance goals for both safety and functionality informs plans for new construction and any needed retrofitting of existing buildings and infrastructure systems. For new construction, such performance goals help improve a community's resilience over time. For existing construction, performance goals help identify clusters of buildings and infrastructure systems that may benefit from retrofitting or other measures to ensure the provision of the needed service.

Recovery phases. Since disaster response and recovery is traditionally organized around sequential recovery phases, it is recommended that the recovery times for building clusters and infrastructure systems be organized in the same manner. The Guide uses the recovery phases as defined by the FEMA National Disaster Recovery Framework (FEMA 2014), as shown in Figure 4-1: short-term, intermediate and long-term. The first phase usually focuses on rescue, stabilization, and preparing for recovery and is expected to last days. The second phase focuses on restoring the neighborhoods, workforce, and caring for the vulnerable populations and extends for weeks to months. The third phase is related to restoring the community's economy and all social institutions and physical infrastructure, and may last for years. Note that activities during each of the recovery phases may overlap in their planning and execution.

Figure 4-1: National Disaster Recovery Framework (NDRF) recovery continuum (FEMA 2011)

Performance levels for buildings.

To ensure that a community planning guide is compatible with codes and standards, common definitions of performance levels are needed for buildings and infrastructure systems. Table 4-1 provides standard definitions for building performance levels that are used in the Guide. These were originally derived by SPUR (2009) to define the seismic performance of buildings to characterize building performance in a transparent manner. They have not yet been fully incorporated into building codes and standards.

Table 4-1: Performance level definitions for buildings

Category	Performance Level
Safe and operational	These are facilities that suffer only minor damage and have the ability to function without interruption. Essential facilities such as hospitals and emergency operations centers and buildings required during Phase 1 (Short Term) should meet this level of function.
Safe and usable during repair	These are facilities that experience moderate damage to their finishes, contents and support systems. They will receive green tags when inspected and will be safe to occupy after the hazard event. This level of performance is suitable for buildings needed in Phase 2 (Intermediate) such as for shelter-in-place residential buildings, neighborhood businesses and services, and other businesses or services deemed important to community recovery.
Safe and not usable	These facilities meet the minimum safety goals, but a significant number will remain closed until they are repaired. These facilities will receive yellow tags. This performance may be suitable for long term recovery including some of the facilities that support the community's economy. Demand for business and market factors will determine when they should be repaired or replaced.
Unsafe – partial or complete collapse	These facilities are dangerous because the extent of damage may lead to casualties. These buildings are generally considered to be exceptionally high risk and needing retrofit in the short term.

Functional categories. Categories based on community functions that support recovery can be helpful when determining desired performance goals for the built environment. Table 4-2 gives an example of the assignment of building cluster by recovery phases. Four functional categories are suggested for inclusion in the three phases of recovery, within which the various building clusters are assigned. The four categories include critical facilities and emergency housing (short term), workforce housing and neighborhood restoration (intermediate term), and community restoration (long term). Communities may find it helpful to consider human and social needs when considering which building clusters are assigned to the three recovery phases.

Table 4-2: Sample assignment of building clusters to recovery phases

Recovery Phase	Building Clusters
1. Short Term	**Critical Facilities**
	• Disaster Debris and Recycling Centers • Emergency Operations Centers • Hospitals and Essential healthcare facilities • Police and Fire Stations
	Emergency Housing
	• Animal Shelters • Banking Facilities (location known by community) • Food Distribution Centers • Emergency Shelter for Emergency Response and Recovery Workers • Faith and Community-Based Organizations • Gas Stations (location known by community) • Nursing Homes, Transitional Housing • Public Shelters • Residential Shelter-in-Place
2. Intermediate	**Housing/Neighborhoods/Business**
	• Buildings or Space for Social Services (e.g., Child Services) and Prosecution Activities • Daycare Centers • Essential City Services Facilities • Houses of Worship • Local Businesses • Local Grocery Stores (location known by community) • Medical Provider Offices • Neighborhood Retail Stores • Residential Housing • Schools
3. Long Term	**Community Recovery**
	• Commercial and Industrial Businesses • Non-Emergency City Services • Resilient Landscape Repair, Redesign, Reconstruction, and Repairs to Domestic Environment

While discrete recovery phases are designated, it is recognized and expected that there will be considerable overlap in their initiation and completion. Each recovery phase could conceivably start shortly after the hazard event.

Functionality levels for building clusters. While individual buildings may be assigned performance levels that reflect their role in the community, the ability of a building cluster to serve its social institutions can also be measured by how many of the buildings in the cluster are functioning. For purposes of planning, it is helpful to set goals for three levels of functionality based on the percentage of buildings in the cluster that are functional, as defined in Table 4-3. This process allows a community to define the shape of the recovery curves shown in Figure 4-1 for each of the recovery phases.

Table 4-3: Functionality levels for building clusters

Category	Performance Level
30% functional	Minimum number needed to initiate the activities assigned to the cluster
60% functional	Minimum number needed to initiate usual operations
90% functional	Minimum number needed to declare cluster is operating at normal capacity

In the post-event environment, 90% functional is considered to be full restoration. In many communities, approximately 10% of the buildings are out of service for a variety of reasons at any given time. The gradual recovery levels also clarifies that all buildings in a cluster are not expected to recover in the same time. Chapter 11 in Volume II provides information on building cluster identification and considerations for setting performance levels.

Supporting infrastructure systems. Building clusters require service from supporting infrastructure systems to be functional. In the short term, temporary solutions may be used to restore service, such as emergency generators or portable water supplies. Communities are encouraged to set functionality levels (Table 4-3) for recovery of infrastructure systems so they support the building cluster recovery. The focus is on system performance in terms of the percentage of capacity provided at the 30%, 60%, and 90% milestones for the various building clusters. Consideration should be given to redundancies inherent in each infrastructure system and the consequence of the outage.

New construction and retrofit. The procedure for setting performance levels for buildings, building clusters, and supporting infrastructure systems is directly applicable to new construction and retrofit projects. The design criteria established for those projects should be based on the same performance goal for the building cluster they support. To achieve the long term community resilience, all new construction should be designed to the community designated performance level.

4.1.3. Define Community Hazards and Levels

With desired performance goals established, the next step is to determine the response of the existing buildings and infrastructure systems to a community's prevailing hazards.

Prevailing hazards. Each community has a set of prevalent hazards to consider when planning for community resilience. The following list of hazards includes those that are often addressed in current practices in the design of the built environment.

- ***Wind –*** storms, hurricane, tornadoes
- ***Earthquake –*** ground shaking, faulting, landslides, liquefaction
- ***Inundation –*** riverine flooding, flash flood, coastal flooding, tsunami
- ***Fire –*** urban/building, wildfire, and fire following a hazard event
- ***Snow or Rain –*** freeze or thaw, rain storms that overwhelm drainage systems
- ***Technological or Human-caused –*** blast, vehicular impact, toxic environmental contamination as a result of industrial or other accidents as well as due to clean-up/disposal methods after a hazard event

Each community should identify and plan for prevailing hazards that may have significant negative impact on the built environment. Communities may have already identified their prevailing hazards using

FEMA's Threat and Hazard Identification and Risk Assessment (THIRA) Guide (CPG 201, FEMA 2013-B).

Hazard levels. For each hazard identified, communities are encouraged to determine three levels of the hazard for planning:

- ***Routine –*** Hazard level is below the expected (design) level and occurs more frequently. Resilient buildings and infrastructure systems should remain fully functional and not experience any significant damage that would disrupt social or economic functions in the community.
- ***Expected –*** Design hazard level, where the design level is often based on codes. The design hazard level may be greater than the minimum required by codes, or may be based on other criteria. Buildings and infrastructure systems should remain functional at a level sufficient to support the response and recovery of the community as defined by the performance levels. This level is based on the design criteria normally used for buildings.
- ***Extreme –*** Hazard level is above the expected (design) level. Some hazards refer to the maximum considered event, which is based on the historic record. Extreme events may also include long-term changes in hazards anticipated due to climate change. However, this hazard level might not be the largest possible hazard level that can be envisioned, but rather one that the community believes is credible. Critical facilities and infrastructure systems should remain at least minimally functional at this level. Other buildings and infrastructure systems should perform at a level that protects the occupants though they may need to be rescued. In addition, emergency response plans should be developed for scenarios based on this hazard level.

Each hazard level should be locally meaningful and be consistent with those used for evaluation and design. Table 4-4 shows design hazard levels based on ASCE/SEI Standard 7-10 (ASCE/SEI 2010). Table 4-5 reports the three levels of seismic hazard defined by SPUR for use in San Francisco's resilience planning.

Table 4-4: Hazard levels for buildings and facilities

Hazard	Routine	Expected	Extreme
Ground Snow	50 year	300 to 500 year[1]	[4]
Rain	[2]	[2]	[2]
Wind – Extratropical	50 year	700 year	3,000 year[3]
Wind – Hurricane	50 to 100 year	700 year	3,000 year[3]
Wind – Tornado	[3]	[3]	[3]
Earthquake[4]	50 year	500 year	2,500 year
Tsunami	N/A	N/A	TBD[3]
Flood	TBD	100 to 500 year	TBD
Fire – Wildfire	[4]	[4]	[4]
Fire –Urban/Manmade	[4]	[4]	[4]
Blast / Terrorism	[5]	[5]	[5]

[1] For the northeast, 1.6 (the LRFD factor on snow load) times the 50-year ground snow load is equivalent to the 300 to 500 year snow load.
[2] Rain is designed by rainfall intensity of inches per hour or mm/h, as specified by the local code.
[3] Tornado and tsunami loads are not addressed in ASCE 7-10. Tornadoes are presently classified by the EF scale.
[4] Hazards to be determined in conjunction with design professionals based on deterministic scenarios.
[5] Hazards to be determined based on deterministic scenarios. Reference UFC 04-020-01 (DoD 2008) for examples of deterministic scenarios.

Table 4-5: SPUR (2009) seismic hazard level definitions

Routine	***Earthquakes that are likely to occur routinely.*** Routine earthquakes are defined as having a 70% probability of occurring in 50 years. In general, earthquakes of this size will have magnitudes equal to 5.0 – 5.5, should not cause any noticeable damage, and should only serve as a reminder of the inevitable. San Francisco's Department of Building Inspection (DBI) uses this earthquake level in their Administrative Bulletin AB 083 (San Francisco Building Code 2014) for purposes of defining the "service level" performance of tall buildings.
Expected	***An earthquake that can reasonably be expected to occur once during the useful life of a structure or system.*** It is defined as having a 10% probability of occurrence in 50 years. San Francisco's Community Action Plan for Seismic Safety (CAPSS) (ATC 2010) assumed that a magnitude 7.2 earthquake located on the peninsula segment of the San Andreas Fault would produce this level of shaking in most of the city.
Extreme (Maximum Considered Earthquake)	***The extreme earthquake that can reasonably be expected to occur on a nearby fault.*** It is defined as having a 2% probability of occurrence in 50 years. The CAPSS defined magnitude 7.9 earthquake located on the peninsula segment of the San Andreas Fault would produce this level of shaking in most of the city.

Hazard Impact. The concept of hazard impact is intended to capture the consequences of an event for a given hazard level. The same hazard level may result in varying levels of consequences, depending on the disruption and damage to the built environment. Two terms are used to address the consequences of the event: the size of the "affected area" and the "level of disruption" to community functions. For example, a wildfire in wilderness areas, where there is little population, can burn many square miles of forest with little disruption. On the other hand, the 1991 Oakland Hills firestorm burned 1500 acres, 25 lives were lost and 150 people were injured. The fire destroyed nearly 3400 structures and caused $1.5 billion in damage (USFA 1991). The affected area was relatively small compared to other wildfires; but the disruption to the affected population and built environment was severe.

To assist communities in determining the anticipated performance of buildings and infrastructure systems (see Section 4.1.4), Table 4-6 defines categories for the size of the "affected area" and "anticipated disruption level." Estimating the impact for a potential hazard event will assist the community's determination of anticipated performance levels and the extent of mutual aide that may be needed.

Table 4-7 shows examples of hazard impacts of past events. Even though the DaVinci Fire became an uncontrolled (extreme) building fire that destroyed the apartment complex under construction (Rocha 2015), the impact on the community was local. The EF5 tornadoes (extreme) affected a portion of Moore (Kuligowski et al 2013), but did not cause disruption to the entire community. In fact, unaffected Moore businesses were able to assist in the recovery. The same hazard event may cause varying level of damage and disruption in communities. The Loma Prieta earthquake caused regional damage and disruptions near Watsonville (Nakata et al 1999), but moderate community level damage and disruption to San Francisco. A hazard event may have sequential hazards, such as winds followed by storm surge during Superstorm Sandy (FEMA 2013). A number of New Jersey communities first lost power when winds came onshore (routine level, less than design wind speeds) and power distribution lines were damaged. When the storm surge subsequently came onshore, a smaller set of communities were inundated but many functions were severely disrupted in these areas.

Table 4-6: Affected area and anticipated community disruption level

	Category	Definition
Affected area	Localized	Damage and lost functionality is contained within an isolated area of the community. While the Emergency Operations Center (EOC) may open, it is able to organize needed actions within a few days and allow the community to return to normal operations and manages recovery. Economic impacts are localized.
Affected area	Community	Significant damage and loss of functionality is contained within the community, such that assistance is required from neighboring areas that were not affected. The EOC opens, directs the response and turns recovery over to usual processes once the City governance structure takes over. Economic impacts extend to the region or state.
Affected area	Regional	Significant damage occurs beyond community boundaries. Area needing emergency response and recovery assistance covers multiple communities in a region, each activating their respective EOCs and seeking assistance in response and recovery from outside the region. Economic impacts may extend national and globally.
Anticipated Disruption Level	Minor	All required response and recovery assistance is handled within the normal operating procedures of the affected community agencies, departments, and local businesses with little to no disruption to the normal flow of living. Critical facilities and emergency housing are functional and community infrastructure systems are functional with local minor damage.
Anticipated Disruption Level	Moderate	Community EOC activates and all response and recovery assistance is orchestrated locally, primarily using local resources. Critical facilities and emergency housing are functional and community infrastructure systems are partially functional.
Anticipated Disruption Level	Severe	Response and recovery efforts are beyond the authority and capability of local communities that are affected and outside coordination is needed to meet the needs of the multiple jurisdictions affected. Professional services and physical resources are needed from outside of the region. Critical facilities and emergency housing may have moderate damage but be occupied with repairs; community infrastructure systems are not functional for most needs.

Table 4-7: Examples of hazard impacts

Event	Community	Year	Level	Affected Area	Disruption Level
DaVinci Apartment Fire	Los Angeles	2014	Extreme	Localized	Minor
Moore OK Tornado	Moore	2013	Extreme	Localized	Moderate
Loma Prieta EQ	Watsonville	1989	Expected	Regional	Severe
Loma Prieta EQ	San Francisco	1989	Expected	Community	Moderate
Superstorm Sandy (wind event)	New Jersey	2012	Routine	Regional	Moderate
Superstorm Sandy (storm surge event)	New Jersey	2012	Expected	Regional	Severe

4.1.4. Determine Anticipated Performance

The anticipated or likely performance of the designated clusters of existing buildings and infrastructure systems also needs to be estimated. Anticipated performance also depend on (1) the likely level of damage that occurs during the hazard event (performance level) and (2) the corresponding recovery time to restore full functionality. The recovery time depends on the performance: a cluster may need limited repairs or perhaps replacement. This information, when compared to the performance goals previously set, defines the gaps that need to be addressed and informs pre-event planning for post-event response.

The majority of buildings and infrastructure systems in service today have been designed to serve their intended functions on a daily basis under the normal environmental conditions. Buildings and other structures are also designed to provide occupant safety during an expected (design) level hazard event, but they may not continue to be functional. The design and construction of buildings and physical infrastructure systems are provided by builders, architects and engineers following their community codes and standards of practice.

The codes and standards are continually evolving due to changing technology, changing needs, and new information, and to address observed performance issues during past events. It is anticipated that much of the existing built environment may not meet the long-term performance goals set by communities.

Temporary or interim solutions can address short term needs while in long term, permanent solutions are set in place.

Assessment of the existing built environment should consider the performance expectations for adopted design codes. Since community resilience focuses on performance at the community level, selected building clusters and infrastructure systems are evaluated against the desired performance goals and functions based on social needs. Current engineering practices for predicting the anticipated performance of buildings and infrastructure systems under specific hazard events are often based on expert judgment or past experience of other communities. These techniques are constantly being developed and improved. Chapters 11 through 15 (Volume II) provide available guidance on how to estimate the performance of existing buildings and infrastructure systems.

The lack of personal experience with a damaging hazard event and the lack of understanding about the level of damage expected when a significant hazard event occurs often lead to misconceptions of a community's vulnerability. Communities can recognize their vulnerabilities based on national experience, not just local events, by adopting and enforcing the current national land use guidelines (e.g., flood zones) and national model codes. The cost of compliance for new construction is often minimal compared to recovery and reconstruction.

4.1.5. Summarize the Results

The desired performance goals and anticipated performance for the built environment are documented to improve communication between stakeholders and to support a comprehensive, high-level summary of the integrated performance of a community's buildings and infrastructure systems. To support the documentation, a matrix-based presentation of the many facets of a community resilience plan has been developed for use with this Guide. It includes a Detailed Resilience Matrix for each of the building clusters and infrastructure systems as well as a Summary Resilience Matrix that provides an integrated community-level overview. The detailed matrix includes the desired performance goals for all clusters and subsystems defined for the community for each hazard level, as well as the anticipated performance levels for the hazard(s) under consideration. The summary matrices combine all of this information together for buildings and infrastructure systems. Example matrices are included in Chapters 11 to 15 (Volume II), and use of the summary and detailed matrices is demonstrated in the appendix example for a fictitious mid-sized city.

4.2. References

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5. Plan Development

It must be emphasized that community resilience is achieved over time with a long-term commitment by the community and its governing body. Administrative solutions and prioritized improvements can be implemented as funds and opportunities become available. The built environment is replaced slowly, and life cycles on the order of 30 to 100 years can be expected for buildings and infrastructure systems, depending on the design, construction, maintenance, and use.

As a starting point, a community can focus on a critical mass of buildings and infrastructure systems to support short-term recovery for the expected hazard event. Similar plans can be developed for the routine and extreme event. Interim or temporary solutions may be developed to allow a rapid return of functions while permanent repairs or improvements are underway. Planning for the deployment of such solutions will provide short-term resilience while the community plans for long-term goals.

The American Planning Association document, Planning for Post-Disaster Recovery: Next Generation (APA 2014), discusses a recovery planning process and related issues. The APA reports that most disaster plans are standalone plans or integrated into other existing plans such as the community's Comprehensive (General) Plan. Standalone plans are easier to develop and update, and may be easier to individually implement. However, an integrated plan brings resources together and links community resilience to other (standalone) plans, which is essential for understanding performance and issues at a community level. This Guide supports development of a comprehensive understanding of what is needed from the built environment for community resilience.

Like all plans, a community resilience plan provides a starting point and a path forward. The community resilience plan should become a working document that is referenced and revised as needed.

5.1. Evaluate Gaps Between Desired and Anticipated Performance

Development of the community resilience plan starts with evaluating gaps between desired performance levels and those that are anticipated for a hazard. Summarizing the information in the matrices provides a record and visual presentation of the recovery time gaps between the desired performance levels and the anticipated performance. Gaps in performance identify areas for improvement to meet social needs.

5.2. Identify Solutions to Address Gaps

With gaps in performance identified through the planning process, alternative options for the restoration of the built environment can be identified and evaluated. There may be multiple solutions or multiple stages to meet desired performance goals, including temporary or short-term solutions to meet immediate needs as well as long-term, permanent solutions.

Both administrative and construction solutions should be considered to improve performance, reduce damage during hazard events, work toward meeting desired times to restore functions, and improve overall resilience across the community.

There are a number of administrative activities with low implementation costs that will yield significant long-term benefit. All communities large and small can identify these solutions and implement them as need to support their needs.

When a hazard event occurs, buildings and infrastructure systems provide protection to the occupants from serious injury or death. This goal can be achieved by adopting and enforcing current building codes and regulations for new construction and, where warranted, retrofitting existing buildings. However, a consideration of public safety, community impact, statutes for enforcement, and an assessment of benefit and cost need to be considered for retrofit of structures.

Construction projects can add redundancies or robustness to buildings and infrastructure systems. For some hazards, such as flooding, the threat can be redirected. Mitigation projects completed prior to significant hazard events can support long-term resilience strategies, reduce demands during recovery, and can speed up the overall recovery process. Mitigation projects often are construction projects, but can also be administrative in nature. For instance, communities can adopt and enforce codes and standards with local amendments that strengthen resilience or develop mutual aid agreements and develop streamlined recovery processes.

Defining and implementing criteria for enhanced resiliency prior to any hazard event can benefit communities whether or not a disaster occurs. Construction related activities for both new and existing construction can also significantly improve community resilience in the long-term. Such projects can be implemented as funding becomes available or following a disaster when opportunities for rebuilding occur.

5.2.1. Administrative Solutions

A community's planning for the physical infrastructure may begin with considering administrative activities and evaluating them as needed. The following list of suggested considerations is not comprehensive. Communities may have other administrative solutions that will support their community resilience goals and strategies.

1. Organize and maintain a resilience office with designated leadership. Whether full or part time, this office is responsible for leading development, implementation, and evaluation of community resilience strategies, including its integration with other community plans, public outreach, collaboration with private stakeholders, and updating the plan on a regular basis.
2. Integrate resilience plans with the General Plan, Emergency Operations Plan, Land Use Plans, Infrastructure and Transportation Plans, Housing Plans, Economic Development Plans, and plans related to the environment. This is a lengthy process that needs collaboration with the responsible agencies or partners and considerable community engagement.
3. Integrate the resilience planning concepts with the FEMA Mitigation Plan (FEMA 2013) and prioritize mitigation grant requests with the resilience plan.
4. Adopt land use planning regulations to manage the green infrastructure (natural capital) that supports community goals and set design standards for construction in high hazard zones, such as flood plains, coastal areas, areas susceptible to liquefaction, etc.
5. Develop processes and guidelines for post-event assessments and repairs that will accelerate the evaluation process and designation of buildings that can be "used during repair."
6. Collaborate with adjacent communities to promote common understanding and opportunities for mutual aid during response and recovery phases. Develop mutual aid agreements as directed by the resilience plan.
7. Publish the performance gaps and resilience plans in transparent and publicly available methods, including announcements of results and progress. This may trigger some voluntary actions on the part of building owners and system operators.
8. Collaborate with State and Federal owned and leased properties to meet community resilience regulations or codes, if they are higher than those currently being used.
9. Develop and implement education and awareness programs for all stakeholders in the community to enhance understanding, preparedness, and opportunities for community resilience.

100 Resilient Cities. Pioneered by the Rockefeller foundation, 100 Resilient Cities (100RC) is dedicated to helping cities around the world become more resilient to physical, social and economic challenges caused by "shocks and stresses" that range from earthquakes, fires, and floods to high unemployment, violence, and chronic food and water shortage. By addressing both shocks and stresses, a city becomes more able to respond to adverse events and is better able to function by utilizing the following four techniques.

1. Establish a fully funded Chief Resilience Officer in city government to lead the city's resilience efforts
2. Solicit expert support for development of a robust resilience strategy.
3. Develop and implement resilience strategies with the help from public and private service providers, partners, and NGO sectors.
4. Network with other member cities and learn from each other.

For more information, see www.100resilientcities.org.

5.2.2. Construction Solutions

Targeted construction projects aligned with a community's resilience goals and plans can greatly enhance community resilience. The following solutions are suggested for consideration when developing resilience plans for significant long-term impacts.

Existing construction

1. Identify opportunities for natural systems protection including sediment and erosion control, stream corridor restoration, forest management, conservation easements, and wetland restoration and preservation and implement solutions.
2. Include retrofitting of public buildings to initiate the resilience implementation process in the community. Retrofit and reconstruction of public facilities not only immediately improves the communities ability to recover, it may provide an incentive to private building owners to do the same.
3. Develop incentives and financial support to encourage buildings to be retrofit to the codes and regulations set by the community to achieve desired performance and community goals.
4. Implement programs to identify which buildings and infrastructure systems need improvements to protect life safety for the prevalent hazards.
5. Consider the need for mandatory retrofitting programs through local ordinances. Develop and announce viable funding opportunities and include some level of public funding.

New construction

1. Adopt and enforce the latest national model building codes, standards, and regulations for the built environment, and add regulations as needed to support community resilience goals.
2. Assure the effectiveness of the building department in enforcing current codes and standards during permitting and construction inspections to ensure that the latest processes are being followed.
3. Enhance codes and standards with local ordinances to support resilience plans and state performance goals in a transparent manner.

5.3. Prioritize Solutions and Develop Implementation Strategy

Once the gaps are evaluated and prioritized relative to community goals, strategies can be developed to mitigate damage and improve recovery of functions across the community. Implementation strategies should align community goals and prioritized gaps and needs through short-term and long-term solutions. This process is compatible with the FEMA Mitigation Plan (FEMA 2013), which many communities are using. The Guide can incorporate mitigation planning into the community resilience process as part of the planning needed to restore community functionality.

Resilience strategies should also identify opportunities to improve the built environment, or "build-back better." After a disaster, there is significant pressure to quickly restore the built environment. Without pre-established strategies and solutions, communities often rebuild to pre-event conditions. With advanced planning, reconstruction can advance community resilience. Immediately after a major hazard event, there is often community support for higher design standards, appropriate land use changes, and requirements to repair and retrofit to higher resilience levels.

5.4. References

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6. Plan Approval, Implementation, and Maintenance

6.1. Plan Preparation, Review, and Approval

To facilitate review and approval by all stakeholders and the community, the community goals and implementation strategy need to be documented with supporting information from Planning Steps 1 through 4 (see Table 1-1). Even though the planning team has included input from stakeholder and community representatives, a comprehensive understanding and support of the final proposed plan by the entire community needs to be developed. Activities such as public comment and review periods and community meetings can help develop understanding about the selected community goals, social needs, existing infrastructure systems, prevailing hazards, and short and long-term benefits of the proposed solutions and actions.

Once the community plan for resilience has been finalized with stakeholder and community input, the plan is adopted by the community to guide local government agency plans, collaborative agreements with private owners and stakeholders, and to provide a legal basis for implementation through local statutes, laws, or ordinances. Formal adoption also establishes the authority required for changes and modifications to the plan.

6.2. Plan Implementation and Maintenance

Community resilience leaders and staff should maintain the master plan that tracks and documents the implementation of adopted strategies and solutions. Implementation also requires active outreach and communication through a variety of mechanisms about progress, support, and benefits accrued over time.

The adopted community plan needs to be reviewed on a regular basis, such as annually, that is consistent with the community planning cycles. Progress can be tracked and publically posted.

The implementation strategy or specific solutions may need to be modified, depending on changes in the social or physical characteristics, unexpected events, or improved understanding of the built environment and impact of prevailing hazards.

7. Future Directions

7.1. Feedback on the DRAFT Guide

Starting April 2014, NIST teamed with public and private sector experts to develop the Community Resilience Planning Guide for Buildings and Infrastructure Systems. A broad network of stakeholders has been engaged via workshops around the country, through public comments, and in direct interactions with community officials and others.

NIST encourages comments and feedback on the Guide. It will be especially valuable to have communities and those with responsibilities for and expertise with the built environment to offer recommendations for improvements. NIST welcomes answers to the following questions, in particular:

- Is this Guide useful in helping communities to better plan for disaster resilience? If so, in what ways is it useful? If not, what is lacking?
- How can the Guide be better organized or presented?
- Will this Guide lead to improved resilience planning and execution at the community level?

7.2. Disaster Resilience Standards Panel

NIST intends to establish a Disaster Resilience Standards Panel (DRSP) as an independent organization for a broad range of stakeholders to address community resilience issues. The DRSP will provide a forum and an organization, independent of any community or other codes or standard bodies, for stakeholders to consider technical issues, recommendations for needed guidance, or new resilience standards for other bodies to consider. Stakeholder interests include community planning, disaster recovery, emergency management, business continuity, insurance/re-insurance, state and local government, standards and code development, and the design, construction, and maintenance of buildings and infrastructure systems (water and wastewater, energy, communications, transportation).

The DRSP is envisioned to be an organization that supports continued development of the Guide and also supports development of documents that will provide more detailed implementation guidance to communities. The panel's mission is not to develop standards – that is the work of voluntary standards developing organizations – but instead to inform the development and lay the foundation for standards and codes produced by those organizations. The panel also intends to develop priority action plans and a resilience knowledge base to provide access to case studies, recognized codes, standards, and guidance to help communities in their endeavors.

DRSP mission. To promote communications and collaboration among all stakeholders of community disaster resilience that will support resilience planning and implementation by developing and revising guidelines, best practices, and other tools.

DRSP goals. To strive for broad stakeholder collaboration and consensus around the following goals and actions needed to achieve community-based disaster resilience:

- Engage and connect community and cross-sector stakeholders by creating a process to encourage and support community resilience
- Identify policy and standards-related gaps and impediments to community resilience
- Raise awareness of system dependencies and cascading effects of disasters.
- Develop consistent metrics and definitions relating to resiliency that are used across sectors
- Reduce barriers to achieving community resilience
- Maintain and improve the Community Resilience Planning Guide
- Prepare Community Resilience Implementation Guideline
- Develop and maintain the Community Disaster Resilience Knowledge Base

8. Glossary

Term/Acronym	Definition
Buildings	Individual structures, including its equipment and contents, that house people and support social institutions.
Built Capital	Buildings and infrastructure systems, including transportation, energy, water, wastewater, and communication and information systems.
Built Environment	All buildings and infrastructure systems. Also referred to as built capital.
Business Continuity	• The capability of an organization or business to continue delivery of products or services at acceptable predefined levels following a disruptive incident. (ISO 22301, 2012). • An ongoing process to ensure that the necessary steps are taken to identify the impacts of potential losses and maintain viable recovery strategies, recovery plans, and continuity of services (NFPA 1600, 2013).
Clusters	A set of buildings and supporting infrastructure systems, not necessarily geographically co-located, that serve a common function such as housing, healthcare, retail, etc.
Communication and Information Systems	Equipment and systems that facilitate communication services, including Internet, cellular and phone services.
Community	• In the NPG, the term ‘community’ refers to groups with common goals, values, or purposes (e.g., local businesses, neighborhood groups). • In this Guide, however, the term ‘community’ refers to a place designated by geographical boundaries that functions under the jurisdiction of a governance structure, such as a town, city, or county. It is within these places that people live, work, play, and build their futures.
Community Resilience	• “The ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies” (PPD-8, 2011). • “The ability to prepare for and adapt to changing conditions and to withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents” (PPD-21, 2013).
Community Social Institutions	A complex, organized pattern of beliefs and behavior that meets basic individual, household, and community needs, including family/kinship, government, economy, health, education, community service organizations, religious and cultural groups (and other belief systems), and the media.
Critical Facilities	Buildings that are intended to remain operational during hazard events and support functions and services needed during the short-term phase of recovery. These facilities are sometimes referred to as essential buildings.
Critical Infrastructure	“Systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters” (PPD-21, 2013).
Dependency	The reliance of physical and/or social systems on other physical and/or social systems to function or provide services.
Disaster	A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources (National Science and Technology Council, 2005).
Disruption	The consequences of a hazard event that results in loss of services or functions in a community.

Emergency Responders	Official and volunteer workers during the short-term phase of recovery, also referred to as the response phase.
Energy Systems	Electric power, liquid fuel, and natural gas generation, transmission, and distribution.
Financial Capital	Financial savings, income, investments, and available credit.
Function	The role or purpose of a particular institution (e.g., education, finance, healthcare) within a community.
Functionality	Capability of serving the intended function, where the built environment provides an operational level that allows a social institution to provide services.
General Plan	A document designed to guide the future actions of a community, with long-range goals and objectives for the local government, including land development, expenditure of public funds, tax policy (tax incentives), cooperative efforts, and other issues of interest (such as farmland preservation, or the rehabilitation of older neighborhoods areas). Also referred to as a comprehensive plan, master plan, or land use plan (Extension, 2015).
Governance Structures	The governing body of a community.
Hazard	A potential threat or an incident, natural or human-caused, that warrants action to protect life, property, the environment, and public health or safety, and to minimize disruptions of government, social, or economic activities (PPD-21 2013).
Hazard Event	The occurrence of a hazard.
Hazard Impact	The quantification of the community consequences of a hazard through affected area and level of disruption measures
Hazard Level	The quantification of the size, magnitude, or intensity of a hazard, such as wind speed, seismic ground acceleration, flood elevation, etc.
Human Caused Disaster	A hazard event caused by human error or a deliberate action including a terrorist activity.
Implementation Strategies	A planned set of actions that taken together will help meet a goal. To achieve community resilience, a set of solutions may include land use planning, codes and standards for new construction, and specific retrofit requirements.
Infrastructure System	Physical networks, systems and structures that make up transportation, energy, communications, water and wastewater, and other systems that support the functionality of community social institutions.
Life Safety	Life safety in the built environment refers to buildings and other structures designed to protect and evacuate populations in emergencies and during hazard events.
Mitigation	Activities and actions taken to reduce loss of life and property by lessening the impact of hazard events.
Performance Goals	Metrics or specific objectives that define successful performance. For the built environment, performance goals include objectives related to desirable features, such as occupant protection or time for repairs and return to function.
Redundancy	The use of multiple critical components in a system to increase reliability of system performance and function, particularly when one of the multiple components is damaged.
Retrofitting	Improving the expected performance of existing buildings and infrastructure systems through remedial repairs and measures that often improve system resistance or strength.
Robustness	The ability of a structure or system to continue operating or functioning under a variety of demands or conditions.
Shelter-in-place	Safely remaining in a building, e.g., a residence, during or after a hazard event.
Social Capital	Although there is no single definition of social capital, broadly the term refers to “social networks, the reciprocities that arise from them, and the value of these for achieving mutual goals” (Schuller, Baron, and Field 2000).

Stakeholders	All parties that have an interest or concern in an operation, enterprise, or undertaking. For community resilience, stakeholders may include representatives from the local government, such as community development, public works, and building departments; public and private owners and operators of buildings and infrastructure systems; local business and industry representatives; representatives of the community's social institutions (e.g., community organizations, nongovernmental organizations, business/industry groups, health, education, etc.); and any other stakeholders or interested community groups.
Technological Hazard	A human-caused event due to an accident or human error.
Transportation Systems	Buildings, structures, and networks that move people and goods, including roads, bridges, rail systems, airports, coastal or riverine ports, and trucking hubs.
Vulnerable populations	Groups of individuals within a community whose needs may go unmet before or after a disaster event, including the elderly, people living in poverty, racial and ethnic minority groups, people with disabilities, and those suffering from chronic illness. Additional social vulnerabilities can include renters, students, single-parent families, small business owners, culturally diverse groups, and historic neighborhoods.
Wastewater Systems	Systems that collect wastewater, move it through a system of pipelines and pump stations to a treatment plant, and discharged into a receiving water.
Water Systems	Systems that are supplied by either surface or ground water, treat and store the water, and move it to the end user through a system of pipelines.
Whole Community	The National Preparedness Goal defines 'whole community' for preparedness efforts to strengthen the security and resiliency of the United States and includes individuals, communities, the private and nonprofit sectors, faith-based organizations, and Federal, state, and local governments.
Workforce	People who provide labor to one or more of the community social, business, industry, and economic institutions.

8.1. References

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Appendix A. Community Resilience Planning Example – Riverbend, USA

A.1. Introduction

Every community is unique. Communities have different social needs, economic drivers, and priorities. They face their own challenges, and have the ability to develop their own solutions to those problems. The goal of this appendix is to provide an example of a fictional community called Riverbend, USA to step-through the process presented in Volume I of the NIST Community Resilience Planning Guide (CRPG) for Buildings and Infrastructure Systems.

Riverbend is a small city with a population of approximately 50,000. It is situated in a valley along the Central River and was settled by farmers and loggers over 160 years ago because of its surrounding fertile land for agriculture and abundant timber resources. The Riverbend economy consists of agriculture, manufacturing, finance, and real estate. It is a typical middle-class city with a median household income close to the national average. Over the past few years, the logging and mining industries have experienced a downturn; however, Riverbend has been successful in transforming its economy by attracting employers to its other growing economic sectors.

Ms. Smith grew up in Riverbend, USA and returned to live there after her community, Rockyside, USA, was impacted by a flood event. Ms. Smith was a former city council member in Rockyside, and was subsequently elected as a City Council Member one year after moving back to Riverbend.

Ms. Smith, deeply affected by the flood event she experienced in Rockyside, advocated to the Mayor for a plan to make Riverbend's buildings and infrastructure systems more resilient. She noted that Riverbend had similar hazard risks to Rockyside and felt that a similar event could happen in Riverbend. Ms. Smith completed some research and felt that the Guide contained a methodology that was flexible enough to use for a community and its use might have produced better results in Rockyside. After several lengthy discussions with other City Council Members, the Mayor asked Ms. Smith to call and lead a City Hall meeting to engage members of the community. The goal of the City Hall meeting was to gauge and build support for developing a plan to make Riverbend more resilient.

At the City Hall meeting, a majority of those who attended supported developing a plan to make Riverbend's buildings and infrastructure systems more resilient. Several community members were concerned at first that there would be a lot of challenges in developing a plan, particularly the cost to support such an initiative. However, after additional discussion about the importance of resilience in their community, members saw the benefits of living and working in a more resilient community and in turn, Riverbend moved forward with developing a resilience plan. In addition, they wanted to be included in the process and offered help where possible. As a result of the support at the meeting, Ms. Smith was appointed by the Mayor to lead formation of a planning team and follow through with the methodology presented in the Guide. With the approval of the City Council and support of the community, Ms. Smith began to implement the Guide as described in Table 1-1 (see Chapter 1).

A.2. Form a Collaborative Planning Team (Chapter 2 of the Guide)

Achieving community resilience requires a broad base of support from stakeholders. As Riverbend would likely need assistance from neighboring communities, regions, and state, it was critical for Ms. Smith to identify and engage stakeholders within the community as well as from the city across the river, Fallsborough. Stakeholders from the public and private sectors were needed to form the team. Ms. Smith led the formation of a large work group representing a broad cross section of Riverbend by including those who could help define social needs in the context of post-event response and recovery phases and those who would contribute to resilience of the built environment to support the identified social needs. Her vision for the organization of the planning process included a planning team overseen by the City Council, and seven task groups, as shown in Figure A-1.

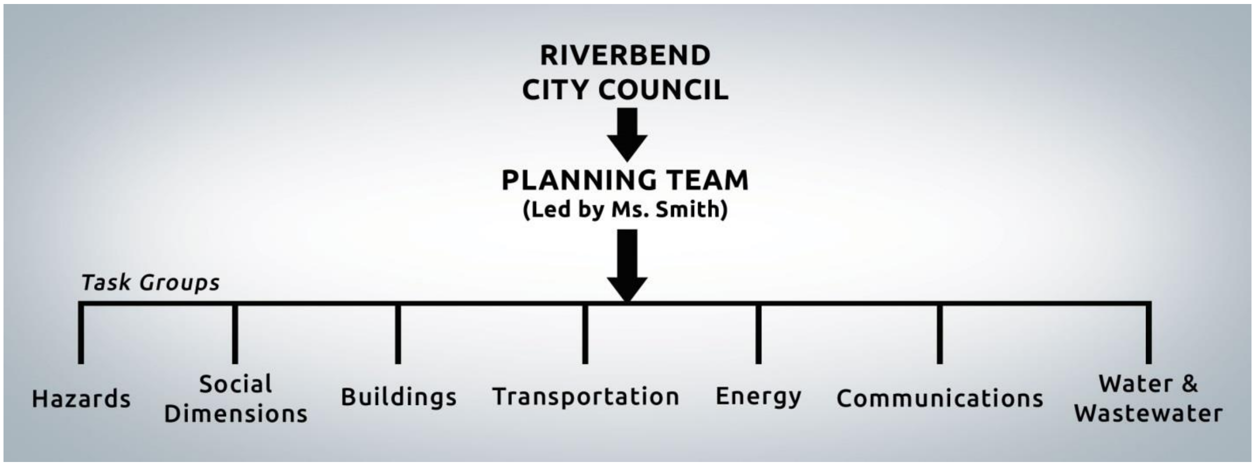

Figure A-1: Riverbend, USA planning team and stakeholder task groups

The planning team, led by Ms. Smith, was responsible for leading development of the Riverbend resilience planning initiative. The planning team reported to the City Council, which provided oversight of the process and eventual approval of the final resilience plan. An important part of the planning team's responsibilities was to coordinate among the different task groups, shown in Figure A-1. These task groups included: hazards, social dimensions, buildings, transportation, energy, communications, and water and wastewater. Members of the task groups who worked with the Riverbend planning team to develop the resilience initiative are shown in Table A-1. A representative from each task group was included on the planning team to help coordinate between the groups and address dependencies between buildings and infrastructure systems. The responsibilities of the task groups were:

- ***Hazards Task Group*** identify potential hazards and appropriate scenarios so that the buildings and infrastructure systems task groups could determine the anticipated performance of the built environment.
- ***Social Dimensions Task Group*** define the social needs and priorities of the community that inform the performance goals for the building clusters and infrastructure systems (i.e., built environment). Table A-2 lists the representatives of the task group by social institution.
- ***Buildings Task Group*** identify and classify the buildings within Riverbend into one of the four building clusters described in the Guide (i.e., critical facilities, emergency housing, housing/neighborhoods, community recovery) to categorize how they meet response and recovery needs of the community.
- ***Transportation Task Group*** identify and characterize the transportation systems within the town boundary and the transportation network at the state and regional level, and how these systems meet response and recovery needs.
- ***Energy Task Group*** identify and characterize infrastructure systems for electric power, natural gas, and liquid fuel systems, and a hydroelectric dam, and their role in the recovery phases.
- ***Communications Task Group*** identify and characterize communication systems, including landline, cellular, broadcast, and cable systems, and their role in the recovery phases. Additional responsibilities included coordinating with emergency response agencies to support emergency communication needs.
- ***Water and Wastewater Task Group*** identify and characterize water and wastewater infrastructure systems, and their role in the recovery phases. Additional responsibilities included coordinating with the public health authority, environmental quality agency, and firefighters to meet community needs.

The task groups worked in parallel, and at times, in collaboration, with oversight from the planning team throughout this planning process.

Table A-1: Riverbend government leaders and community stakeholders

City Council	Planning Team	Hazard Task Group
• Mayor • Four Commissioners • Auditor	• Resilience Lead (Ms. Smith) • City Manager • City Engineer • Public works representative • City planner • Riverbend Office of Emergency Management • Land developers • Buildings department • Finance representative • Community outreach/ Public information • Representative from each task group	• State geological survey • Riverbend Department of Community Development • University hazard specialist(s) • Flood plain manager • U.S. Army Corps of Engineers • Department of Environmental Protection
Social Dimensions Task Group	**Buildings Task Group**	**Transportation Task Group**
• See Table A-2 for representatives by Social Institution.	• Building owners • Critical facility managers (hospitals, schools) • Privately owned building stock representative(s) • Local industry facility managers • General contractor • Real estate representatives • Engineers • Developers • Construction firms • Fire department	• State and County Departments of Transportation • Engineer from Riverbend Department of Public Works • Railroad representatives • Emergency management representatives • Traffic engineer • Bridge engineer
Energy Task Group	**Communications Task Group**	**Water and Wastewater Task Group**
• Regional generation representatives • Distribution system provider (load serving entity) • Electric power engineer • Riverbend Office of Emergency Management • Liquid fuel distributor • State Public Utility Commission (PUC) • State Department of Energy	• State PUC • Telecommunication service providers • Riverbend Office of Emergency Management	• Riverbend Department of Public Works • Fallsborough City water engineer • Emergency manager of Regional Fire and Rescue • Environmental quality agency

Table A-2: Social Dimensions Task Group by social institution

Family and Kinship	Economic	Government	Health
• Neighborhood representatives • Citizens groups	• City Chamber of Commerce • Retail managers • Gas station managers • Banking and finance sector • Local major industries	• Police and Fire/EMS • City Department of Parks and Recreation • Senior living center • Aging and People with Disabilities Services • Courts	• Local Health Department • Hospitals • Urgent care/health offices
Education	**CSOs**	**Religious/Cultural**	**Media**
• Public schools • Private schools • Community college/higher education	• Shelter/Food bank representatives • American Red Cross • Recreational/civic clubs or groups	• Local religious, cultural, or belief groups	• Local media outlets

A.3. Understanding the Situation (Chapter 3 of the Guide)

Once the planning team and task groups were created, the next step was to characterize both the social and built environments. As such, the planning team assigned the social dimensions task group to characterize the social environment in a brief report. Similarly, the planning team asked each of the building and infrastructure system task groups to characterize their portion of the built environment in a brief report. The hazards group was tasked to complete a report on the potential hazards that Riverbend might face and, thus, would have to consider (see Section A.4.3). These reports were all completed in parallel. The planning team, including the representatives of each task group, then worked together to determine the links between the social and built environments. The following sections summarize the brief reports of the task groups, except for the hazards task group which is addressed in Section A.4.3.

A.3.1. Identify and Characterize the Social Dimensions (Section 3.1 of the Guide)

Overall Riverbend is a typical middle-class city with a median household income close to the national average. Riverbend's economy is diverse (Table A-3), consisting of trade, government, manufacturing, education and health services, finance and business services, hospitality, and construction. One of the largest single employers in Riverbend is the National Aircraft Parts (NAP) factory. NAP manufactures aircraft parts for the region and employs over 3,000 people, many of whom live in Riverbend. NAP is also the sole supplier of parts critical to the armed services. About 40% of the community's workforce is employed by small businesses. As the mining and logging industries have declined, Riverbend has been successful in transforming its economy by attracting employers to its growing professional services, business sector, and transportation sector.

Table A-3: Employment for Riverbend, USA

Employment by Industry	Percentage
Trade, transportation, and utilities	22
Government	18
Manufacturing	17
Education and health services	13
Professional and business services	8
Leisure and hospitality	8
Construction	5
Financial activities	4
Other services	3
Mining and logging	1
Information	1

According to 2010 United States Census, the median household income is slightly above the U.S. national average at $52,612 (see Table A-4). Almost 20% of the population, 25 years and older, have a four-year degree or higher. Statistics show the diversity in age of the city, with 40% of the population under the age of 18, and 13% of the population 65 years of age or older. Additionally, approximately 15% of the population in Riverbend has a disability, as defined by the U.S. Census Bureau report: "Americans with Disabilities: 2010" (Brault, M.W. 2012).

Table A-4: Riverbend, USA population demographics

Population Demographics	Values
Household Income under $35,000	32%
Household Income over $100,000	13%
Median Household Income	$52,612
Households from Different State within last 5 years	11%
Population (25 +) with Four Year Degree or Higher	18.4%
Population (25+) with Graduate Degree	6.1%
Ratio of "Transfer" Payments* to Earned Income	18%
Households receiving Food Stamp/SNAP Benefits	15%
Unemployment Rate	5.5%
Population below 18 years	40%
Population 65 Years of Age or Above	13%
Population with Disabilities	15%
Employed Population, uninsured	82%
Unemployed population uninsured	63%
Gender (female)	51%

*Refer to social security and cash public assistance

The rate of emigration is low in Riverbend. A large percentage of the housing units are owner occupied: 59%, and the homeowner vacancy rate is 2.6%. Additionally, according to a demographic study conducted by the state university two years ago, the population of Riverbend is growing and is expected to grow steadily over the next three decades.

Riverbend is governed by its City Council, which includes the Mayor, four Commissioners, and an auditor (see Table A-1). The city's Office of Neighborhood Services provides a conduit between city government and Riverbend's neighborhood associations. With the number of families living in the city, Riverbend’s government has an active parks and recreation department. The department maintains the city’s widely-used bike paths, local parks, and walking/hiking trails. Additionally, there is a popular senior center and a number of golf courses located in the area.

The police and fire departments play an active role in public safety for the city. The city is served by Central Regional Fire and Rescue, a special purpose district for providing firefighting and emergency services. Because Riverbend is so close to the Central River, two of the four fire stations within Central Regional Fire and Rescue have water rescue capabilities. Additionally, there is a close relationship between the Central Regional Fire and Rescue and Riverbend Department of Public Works. The Police department in Riverbend has over 80 staff members, a third of which are civilian, to conduct all patrol, detective, K-9, SWAT, dispatch, education, animal control, and records services.

Riverbend’s health system offers a variety of health services, including provision of mental health services. The county department of health is located within the city limits. Additionally, Memorial Hospital provides a 76-bed facility, with over 130 health care providers on staff. There are two additional urgent care facilities and a local non-profit healthcare provider.

Riverbend is served by a public school district and a few additional private schools. There are a total of 23 K-12 public schools within the school district, serving approximately 9000 students. In addition, there is a 2-year community college situated on the north edge of the downtown area, which serves over 12,000 students.

Riverbend offers several different programs to provide social support to its members in need. Two food banks provide services to approximately 10,000 people each year from around the region. Riverbend also has a homeless shelter that provides food, shelter, clothing, counseling and mental health referrals to over 100 homeless people each day.

Riverbend has local print and radio media; however the city does not have a local television station devoted to its city news. It relies on a nearby city, Fallsborough, for local television news.

Overall, the members of Riverbend have a good quality of life. There is a healthy percentage in the workforce – both inside and outside the community. There is limited public transportation available, but most households have at least one vehicle, with 90% relying on personal transportation (including carpool) to commute to and from work. Historically, the unemployment rate has been close to the national average. Riverbend’s members are involved in the government and community groups. Many neighborhoods have citizen watch groups, and these groups have become involved in safety-related city government decisions in the past.

Once the social dimensions task group characterized the social environment, as summarized above, they worked to identify the dependencies among and within Riverbend’s various social institutions. As described in the methodology provided by the Guide, the task group recognized that a disruption in the built environment that affects one social institution is likely to affect other social institutions. Using the templates provided in Chapter 9, Volume II of the Guide (Tables 9-3 and 9-4), members of the group worked collaboratively to identify ways in which the social institutions in Riverbend depend on each other, as well as how different entities within Riverbend’s social institutions rely on each other. For example, Riverbend’s community members rely on businesses, including National Aircraft Parts, for employment and services, such as daycare. As another example, the team identified an important link between their community members and the city’s government services, in that, without people in the community in the wake of a disaster, there will be a diminished workforce available to maintain the government's critical services, including fire and police services, emergency medical services, and emergency operations. Filling out these tables with information specific to Riverbend helped members of the task group to understand these dependencies—information that they then shared with the rest of the planning team. This process helped identify the functions that are most critical during the recovery phases.

A.3.2. Characterize Built Environment (Section 3.2 of the Guide)

The buildings and infrastructure within and surrounding Riverbend were built over a long period of time. Roughly one-third of the downtown area lies within the 100 year flood plain. In general, the buildings and infrastructure in the downtown area were constructed soon after the city was founded, and so, are older than the other buildings and infrastructure within Riverbend. Following a downturn of the logging industry in the 1970s, the health of the downtown area suffered, and many residents left for surrounding neighborhoods with the community. The city limits expanded, and the associated infrastructure to support this geographic growth absorbed much of Riverbend's resources. Downtown became characterized by lower-income residents and smaller businesses.

In the past 10 years, changing demographics have made downtown more attractive and there is significant reinvestment in the downtown building stock and urban renewal.

As previously discussed, each of the building and infrastructure system task groups were asked to develop a brief report on the status of their portion of the built environment. The following summarizes each of the key findings in their reports.

Buildings. The building stock in Riverbend covers a wide array of construction from unreinforced masonry buildings constructed over 100 years ago to single unit timber framed houses built from 1950-1990. Modern steel mid-rise buildings are also found within the community, mainly for commercial or industrial purposes. There remains a significant stock of unreinforced masonry buildings in the downtown area adjacent to the river. Table A-5 summarizes buildings by occupancy class.

Table A-5: Building occupancy class and building count

Occupancy Class	No. of Buildings
• Residential	
▪ Single family dwelling	11,131
▪ Mobile home	1,292
▪ Multifamily dwelling	3,073
▪ Temporary lodging	9
▪ Institutional dormitory	30
▪ Nursing home	5
• Commercial	
▪ Retail trade	175
▪ Wholesale trade	88
▪ Personal and repair services	176
▪ Professional/technical services	270
▪ Banks	18
▪ Hospital	3
▪ Medical office/clinic	62
▪ Entertainment/Recreation	122
▪ Theaters	5
▪ Parking	-

Occupancy Class	No. of Buildings
• Industrial	
▪ Heavy	65
▪ Light	45
▪ Food/drug/chemicals	13
▪ Metals/minerals processing	4
▪ High technology	-
▪ Construction	147
• Agriculture	38
• Religion/Non-Profit	77
• Government	
▪ General Service	27
▪ Emergency Response	9
• Education	
▪ Grade schools	30
▪ College/University	10

Transportation. Riverbend is bisected by an interstate freeway. It also includes state, county, and local roadways. Although there are other transportation systems in the region, including a regional airport and freight rail line, people rely on the roadway system for personal transport and goods are delivered by truck. The regional airport is located 30 miles away from Riverbend, and has limited commercial airline service.

Only one bridge crosses the Central River. It is a 4-lane interstate bridge that is the primary crossing of the Central River in the region, completed in 1955 and widened in 1980. The next crossing of the Central River is 10 miles north. The bridge also carries the water main from the Fallsborough Water Treatment Plant into Riverbend, identifying an important dependency between the transportation and water systems. Therefore, failure of this bridge would significantly disrupt water service to the residents and businesses of Riverbend.

Within the downtown area, many rely on transit bus service for mobility. Commuter bus service to Fallsborough provides transit access for workers. However, personal automobiles are the primary means of mobility for the majority of the population, and traffic during peak commute times is a frequent complaint for residents.

Energy. Riverbend Gas and Electric is an investor-owned utility that provides power and natural gas to Riverbend. It purchases power from a hydroelectric power plant located in Fallsborough that is maintained by US Army Corp of Engineers. There are no petroleum refineries in Riverbend. Liquid fuel is transported to Riverbend via a liquid fuel pipeline from the neighboring major industrial center.

Electric power distribution is predominately through overhead transmission lines with a single crossing of the Central River.

Communications. One national and one regional telecommunication company provide internet, cellular and landline phone, and cable services to residents and businesses in Riverbend. Though these companies operate within a competitive environment, they have managed to co-exist and have been able to work together in the past. The smaller, regional company has similar technology and shares infrastructure with the national company. In fact, the smaller regional service provider leases space from the national company's regional Central Office, located outside of Riverbend.

Water and wastewater. Riverbend does not have a water treatment plant. It gets its drinking water from Fallsborough, which is a wholesale provider selling treated water to a number of neighboring cities. Riverbend relies on County Environmental Services to treat sanitary sewage and storm water. The Riverbend Department of Public Works is responsible for designing, constructing, operating, and maintaining the city's water and wastewater infrastructure.

A.3.3. Link Social Dimensions and the Built Environment (Section 3.3 of the Guide)

Once the task groups characterized the social and built environments, representatives of the task groups worked with the planning team to link the social needs and institutions to the built environment. (Note: Chapter 9 in Volume II of the Guide provides examples of how to accomplish this goal). This is a key step in the process of addressing community resilience because the eight social institutions identified in the Guide (i.e., government, education, economics, health, family, media, religious/cultural groups, and community service organizations) rely on the built environment to function.

Following the approach in the Guide, the Riverbend planning team created one table for each infrastructure system (transportation, water and wastewater, energy, and communication) and for buildings. The tables summarize the following information for each social institution: 1) Purpose of the infrastructure system or buildings; 2) How that purpose is actualized; and 3) Direct and indirect consequences that may occur in a hazard event—to individuals, groups, and the community—when the built environment has degraded functionality.

The Riverbend planning team found that identifying the direct and indirect consequences of a hazard event was particularly helpful with developing priorities and community performance goals when planning for resilience (the next step in the process – see A.4).

Table A-6 shows a partially completed table that links the social institutions and transportation systems. Although the entire table was completed by the Riverbend planning team, the table presented here shows their highest priorities. Table A-6 shows that the transportation network of roads, and one interstate bridge, are used to distribute goods for processing, as well as final goods for sale. The transportation network or roads and the interstate bridge allows consumers to access goods and services and provides a means for the workforce to get to and return from work. The regional airport (located outside of the community) is also included in the table, but only provides limited commercial flights. The table also shows that the loss of any of these systems can lead directly to disruptions in the supply chain (i.e., commerce) and an increase in the time commuters will spend on the road, potentially increasing their commuting costs. Indirect impacts are also listed in Table A-6 to capture the potential for cascading effects. Riverbend noted that supply chain disruptions could lead to dwindling market share and impact prices.

Table A-7 shows how the Riverbend planning team characterized their social institutions' reliance on the buildings within their community. Similar to Table A-6 (Links between Riverbend's social institutions and transportation systems), Table A-7 only shows the highest priority links identified by the planning team. The table emphasizes the importance of the city's downtown area to the city's economy, as well as importance of the city's local government to the day-to-day operation (and overall safety) of the city.

Table A-6: Links between Riverbend's social institutions and transportation systems

	Purpose of Transportation within each Social Institution	**How Actualized within Built Environment**	**Possible Impacts if Transportation Systems are Damaged**	
			Direct	**Indirect**
Family	• Access to and from housing	• 1 Interstate road • 1 freight rail line • 1 bridge for vehicular traffic • Regional airport	• Displaced population (lack of access) • Inability to physically connect with others	• Demand for short-term/ nearby shelter
Economic	• Distribute goods for processing • Obtain labor and capital • Distribute intermediate goods • Distribute final goods for sale • Bring sellers (providers) and consumers together • Getting to and from work		• Supply chain disruptions • Loss of employment • Increase in commuting time and costs • Consumers unable to obtain goods and services	• Loss of taxes, market share • Price increases
Government				
Health				
Education				
CSO				
Religious Org				
Media				

Note: Only the highest Riverbend priorities are shown in this table. The entire table was completed by the planning team.

Table A-7: Links between Riverbend's social institutions and buildings

	Purpose of Buildings within each Social Institution	How Purpose is Actualized within Built Environment	Possible Impacts if Buildings are Damaged	
			Direct	Indirect
Family				
Economic	• Point of sale • Location of employment, gathering points • Prepare materials for transport • Store materials • House equipment and machinery • Design and develop aircraft parts	• City's downtown: ▪ Stores ▪ Restaurants ▪ Bank ▪ Salon and barbershop ▪ Internet cafe ▪ Houses and apartments • National Aircraft Parts plant	• Loss of revenue • Loss of goods and services for sale • Loss of employment • Loss of income • Loss of housing • Loss of materials • Decrease in social capital	• Loss of taxes, market share • Price increases
Government	• Provide work and meeting space for leaders and staff • House public safety and emergency response capabilities	• Offices • Police stations • Fire and EMS stations • Emergency operations center (EOC) • Jail • Courthouse • Libraries	• Diminished emergency response • Disruption to government continuity • Loss of archived materials	• Increased causalities and economic damage
Health Care				
Education				
CSO				
Religious Org				
Media				

Note: Only the highest Riverbend priorities are shown in this table. The entire table was completed by the planning team.

Table A-7 shows that the purpose of the buildings within the downtown district, from an economic standpoint, are to primarily provide: 1) goods and services for consumers, 2) housing, and 3) jobs for community members. The downtown district consists of small-business retail, restaurants, a bank, a salon and barbershop, an internet café, as well as houses and apartments. The community benefits from a strong economy and sales tax. The downtown buildings also provide places for people to gather and socialize, increasing the social capital within the community. The loss of the buildings in the downtown area would result in loss of income and employment for workers, access to goods and services, revenue for the businesses, housing for community members, and potentially reduced social capital.

Table A-7 also shows that the purposes of the manufacturing plant facility, i.e., National Aircraft Parts (NAP), are to provide a place to: 1) store materials; 2) house equipment and machinery vital to manufacturing aircraft parts; 3) design and develop the parts; and 4) prepare materials for transport. The loss of this facility would result in the loss of income and employment for workers, loss of access to goods, loss of materials, and loss of revenue for the plant. Without the downtown area or the NAP, Riverbend might also experience indirect losses, such as a decrease in tax revenues.

Among other functions, Riverbend's government buildings provide office and meeting spaces for community leaders and staff and house public safety and emergency response capabilities (especially important during and after a hazard event). Government buildings within Riverbend consist of police stations, fire and EMS stations, an emergency operations center, government office spaces, a jail, a courthouse, and libraries. The loss of any of these systems can disrupt continuity of government services, and damage to critical facilities can lead to diminished emergency response.

Although the transportation system and buildings were high priority concerns for Riverbend, the planning team recognized that dependencies were a key consideration. Specifically, buildings would not be functional without services from the supporting infrastructure systems: energy, transportation, water and wastewater, and communications. Therefore, Riverbend began to think about the dependencies between buildings and infrastructure systems with a focus on continued functionality of critical buildings in the downtown area that would have a significant impact on public safety and Riverbend's economy.

As they considered dependencies and social needs, the planning team worked with the task groups to identify the building clusters and supporting infrastructure systems. Table A-8 shows the building clusters identified by the Riverbend planning team: Critical Facilities; Emergency Housing; Housing/Neighborhood/Business; and Community Recovery. Table A-8 also shows some specific buildings that were included in the building clusters. As previously discussed, the NAP factory employed over 3,000 people in and around Riverbend, as well as supplied products to other parts of the aircraft industry in the region. NAP is also the sole supplier of parts critical to the armed services, making it important at the national scale as well. Interruptions to its functionality could be costly to the local and regional economies, and impact the nation's armed services. Therefore, the Riverbend planning team decided to categorize NAP as part of the Critical Facilities Building Cluster.

Table A-8: Riverbend, USA building clusters

Buildings in Clusters	
Critical Facilities	**Housing/Neighborhoods/Business**
1. Police and Fire/EMS Stations 2. Emergency Operations Centers 3. Memorial Hospital and Urgent care facilities, including pharmacies 4. Disaster Debris and Recycling Centers 5. National Aircraft Parts Factory	**1.** Waste Management Facilities **2.** Schools **3.** Medical Provider Offices **4.** Downtown District **5.** Local Businesses outside of the downtown area **6.** Daycare Centers **7.** Religious/Cultural Centers/Facilities **8.** Fitness Centers **9.** Buildings or Space for Social Services (e.g., Child Services) and Prosecution Activities
Emergency Housing	**Community Recovery**
1. Residential Shelter-in-Place **2.** Food Distribution Centers **3.** Animal Shelters **4.** Faith and Community-Based Organizations **5.** Emergency Shelter for Emergency Response and Recovery Workers **6.** Gas Stations **7.** Banking Facilities	**1.** Residential Housing **2.** Commercial and Industrial Businesses, except National Aircraft Parts Factory **3.** Non-Emergency City Services **4.** Resilient Landscape Repair, Redesign, Reconstruction, and Repairs to Domestic Environment

A.4. Determine Goals and Objectives (Chapter 4 of the Guide)

After the planning team worked with the task groups to characterize the social and built environments of their community, they were ready to begin developing their community resilience plan.

A.4.1. Establish Long-Term Community Goals (Section 4.1.1 of the Guide)

In establishing long-term community goals for resilience, the planning team reviewed the links between the social and built environments. They used these links to understand what long-term building and infrastructure investments would best improve the resilience of their community. Several of the task groups proposed potential projects in their reports that they felt were necessary to improve the resilience of the built environment. However, the planning team realized that addressing all of these issues would require more resources than were available. Therefore, the planning team worked with the task groups to identify the overall community goals. In addition, the social dimensions task group provided a list of specific metrics to track, over time, the ability of team decisions and investments to achieve long-term community goals. Although there were many goals, they chose to focus on addressing three long-term goals that would make Riverbend more resilient:

1. Minimizing disruptions to daily life and commerce
   - Metric: Average commute time
2. Stabilizing employment and attracting new businesses to support economic growth
   - Metrics**:** Jobs added; tax base value
3. Strengthening ability of government and critical facilities to function after hazard events.
   - Metrics: Government services outages (number); disaster response drill performance; emergency response time

A.4.2. Establish Desired Performance Goals (Section 4.1.2 of the Guide)

Once the community goals were established, the planning team worked with the task groups to establish desired performance goals for the built environment in Riverbend, USA. The planning team developed desired performance goals for each hazard level: a routine event, an expected event, and an extreme event. The desired performance goals were established independently of the hazards faced by the community, as they are based on what is needed to provide social services and functions during recovery phases. The following high-level desired performance goals were set based on the established social needs for Riverbend, USA:

1. For a routine event, Riverbend should:
   - Meet its social needs within 1-3 days of the hazard event (i.e., short-term)
   - Buildings and infrastructure systems should be fully functional within 3 days of the hazard event
2. For an expected event, the city should:
   - Meet its social needs within 1-12 weeks (i.e., intermediate term)
   - Complete reconstruction projects within two years of the event
3. For an extreme event, the city should:
   - Preserve critical facilities, including key industry (e.g., NAP)
   - Meet social needs within 4 months (i.e., long-term)
   - Complete reconstruction within 3-4 years.

Having these high-level goals in mind, the planning team worked with the building and infrastructure task groups to set specific performance goals for buildings and infrastructure systems in their community using the blank matrices in Chapters 11-15 (Volume II) of the Guide.

The planning team developed performance goals for routine, expected, and extreme hazard levels (see Section A.4.3). Table A-9 presents a matrix of the performance goals tables presented in this Appendix. Although all of these tables are shown in this Appendix, only the expected level event is discussed in detail for brevity.

Table A-9: Summary table for resilience matrices of routine, expected, and extreme event

Hazard	Routine Hazard	Expected Hazard	Extreme Hazard
Building	Table A-19	Table A-12	Table A-26
Transportation	Table A-20	Table A-13	Table A-27
Energy	Table A-21	Table A-14	Table A-28
Water	Table A-22	Table A-15	Table A-29
Waste Water	Table A-23	Table A-16	Table A-30
Communications	Table A-24	Table A-17	Table A-31

Like the Guide, the Riverbend planning team used 30%, 60%, and 90% to indicate their performance goals in the tables. Recall that:

- 30% represents the fraction of buildings within a cluster or portion of infrastructure systems that need to be functional to initiate recovery activities
- 60% represents the fraction needed for usual (i.e., daily) operations
- 90% represents the fraction needed to declare the building cluster or infrastructure system at normal operating capacity.

The following summaries briefly describe the key considerations taken into account by the Riverbend planning team and their task groups when they completed the performance goals tables for the expected hazard event (see Table A-12 to Table A-17 in Section A.4.4 for performance goals tables and details on anticipated performance):

Buildings (Chapter 11 in Volume II). The planning team felt that critical facilities should experience little interruption or damage in an expected hazard event (see Table A-12, page 59) since these facilities were needed to support recovery and emergency services to the rest of the community. The NAP factory was also considered a critical facility due to its high level of employment and importance to the nation's armed services. Therefore, it was important that it experience little interruption in an expected hazard event. The Emergency Housing cluster would also need to perform well so that it could be used in the days and weeks following an expected hazard event. The planning team made this decision because they felt that the performance goals for the Housing and Community Recovery building clusters could be made less stringent if emergency housing was available. Furthermore, the planning team decided it would be unreasonable to set performance goals for older buildings (e.g., unreinforced masonry) that were too high.

Transportation (Chapter 12, Volume II). The planning team found that many of the example transportation system components in the Guide example performance goals table (see Chapter 12 in Volume II) did not apply specifically to their community. Therefore, they only included the appropriate components in the performance goals table completed for Riverbend (see Table A-13, page 60).

As previously discussed, the four-lane interstate bridge over Central River between Riverbend and Fallsborough was a major concern for the community because it was the only crossing that carried traffic and clean water into Riverbend from Fallsborough. As seen in Table A-13, the planning team, after engagement with the State Department of Transportation (DOT), felt that the bridge should be inspected for structural damage the day of the hazard event to ensure that the bridge could be declared safe for emergency vehicles. The bridge could then be reopened with one lane in each direction (60%) while the exterior two lanes were closed to permit a detailed inspection of damage to the fascia and soffit of the bridge. All lanes of the bridge would then be open the day following the hazard event, making the bridge fully operational (90%). Although the regional airport was not within the community, the planning team worked with representatives from the Airport to understand the impact an expected event could have on its functionality so Riverbend would know how it would affect their businesses.

Riverbend is served primarily by local roads. As such, the planning team set goals for the transportation system's service to these building clusters to be fully operational within 1 to 3 days. The first few days would be used to clear debris, if necessary.

Energy (Chapter 13 in Volume II). Similar to the transportation performance goals table, the planning team used the example Energy performance goals table in the Guide (see Chapter 13), and only included the relevant rows. Specifically, Riverbend's energy is generated solely by a hydroelectric power plant. Interruption to this facility would shut down the power system, which could in-turn cause critical facilities within Riverbend to become non-functional. However, Riverbend worked with the power plant operators and were told that it was designed such that continued functionality in an expected disaster event was a reasonable goal.

For power infrastructure serving critical facilities, the goal was set to be able to continue normal operations during or immediately after the hazard event and operate at full capacity the next day (see Table A-14, page 61). In general, restoration of the transmission and distribution infrastructure was needed to make the building clusters operational within 1 to 3 days.

Water (Chapter 15 in Volume II). There was only one water main crossing the river from Fallsborough to Riverbend, as previously discussed. The main concern for water, as is the same of other infrastructure systems, was distribution. Critical facilities needed to have water within 1 to 3 days to be fully functional.

However, it was felt that housing and businesses would need water in one week (indicated as by the 90% in Table A-15, page 62).

Wastewater (Chapter 15 in Volume II). The wastewater infrastructure system was important to ensure that Central River would not be polluted with raw sewage and to ensure backlogs at the systems did not impact the community. The planning team set a goal of one week for the wastewater treatment plant to operate with primary treatment and disinfection (indicated as 1 to 4 weeks in Table A-16, page 63). However, they realized that meeting all regulatory requirements may take some time after an expected event, and therefore set a goal of meeting those requirements in 6 months (shown as 4-36 months in Table A-16).

Communications (Chapter 14 in Volume II). The planning team recognized that working with the local service providers was essential to setting realistic performance goals for communications infrastructure. As previously mentioned, the regional and national telecommunications companies that served Riverbend work together in many ways. They share a regional Central Office, and exchange nodes. The service providers told the community they thought that it was reasonable for these nodes to perform well in an expected hazard event because of many of the endeavors that they already had underway themselves to make these facilities more resilient.

The service providers worked with the communities directly to understand the community priorities through establishing performance goals. In terms of the 'last mile' (i.e., distribution system), the performance goal of little to no disruption to critical facilities such as hospitals, fire stations, and the EOC was set (see Table A-17, page 64) to facilitate disaster recovery and emergency services. The service providers were comfortable with this, but stated that it would take 1 to 4 weeks (typically 1 week) to restore full functionality to communications infrastructure serving other building clusters. The community agreed that this was a reasonable performance goal to set.

A.4.3. Define Community Hazards and Levels (Section 4.1.3 of the Guide)

Table A-10: Hazards considered by Riverbend, USA

Hazard	Routine	Expected	Extreme
Earthquake	72-year	500-year	2,500-year
Flooding	50-year	100-year	500-year

The next step in the process was for Riverbend to identify the hazards to which their community is susceptible. The hazards task group, working in parallel with the other task groups, reviewed existing hazard risk maps and historical events that had struck Riverbend in the past. They found that earthquake and flooding were the main hazards that affected Riverbend, as shown in Table A-10, and there was precedent for considering these hazards in the resilience plan.

Riverbend experienced a major flood event in 1861 (known locally as the Great Flood), shortly after the city's founding. Because there were few buildings and little infrastructure at the time, this event did not cause significant damage. There have been a number of lesser flood events through the years, and protective measures such as levees were constructed to protect the city. While the levees limit the effects of flooding, parts of the downtown area are prone to flooding and suffered decline over the years. The planning team also identified the wastewater treatment plant, National Aircraft Parts Factory, and the bridge crossing the Central River as potentially vulnerable to flooding. Based on their review of flood hazard maps and available historical data for Riverbend, the hazards task group determined that the 500-year flood elevation was an appropriate extreme flood event for planning.

Since Riverbend had adopted modern codes for buildings and residential construction, the seismic hazard was determined from the seismic maps for the area. Therefore, the expected event was based on an event with 10% probability of occurrence in 50 years (the 500-year event) and the extreme event was based on a 2% probability of occurrence in 50 years (the 2500-year event). The hazards group reported to the planning team that the 500-year event was appropriate to consider for most buildings. However, the task group also stated that buildings and infrastructure systems identified as critical to the community should be designed for the extreme event.

A.4.4. Determine Anticipated Performance (Section 4.1.4 of the Guide)

Although the desired performance goals were determined based on the social needs of Riverbend (independent of hazard type), the planning team asked the task groups for buildings and the infrastructure systems to complete an analysis of the anticipated performance of the elements for which performance goals were set. The planning team had limited funds to carry out the analysis. Therefore, the team instructed the task groups to analyze the existing buildings and infrastructure systems using data regarding performance during past flood and earthquake events in Riverbend, review of standards and codes to which the structures were built, and use expert judgment.

Unlike the performance goals themselves which were set independent of hazard type (i.e., only considered hazard level), the anticipated performance was based on specific hazard types (e.g., flood, earthquake) and levels. Using the same matrices (previously used to set performance goals), Riverbend determined anticipated performance for their built environment based on each hazard type (i.e., earthquake and flood) and hazard level (i.e., routine, expected, and extreme). Table A-11 presents a matrix of the tables that display anticipated performance in this appendix. Only the hazards type and level combinations listed in Table A-11 are shown in the appendix for brevity; however, Riverbend created matrices for all three hazard levels (routine, expected and extreme) for both flood and earthquake hazards. Additionally, although all of the tables listed in Table A-11 are shown in this appendix, only the expected level event for earthquake is discussed in detail (again, for brevity).

Table A-11: Summary table for resilience matrices of routine, expected, and extreme events

Hazard	Routine Earthquake	Expected Earthquake	Extreme Flooding
Building	Table A-19	Table A-12	Table A-26
Transportation	Table A-20	Table A-13	Table A-27
Energy	Table A-21	Table A-14	Table A-28
Water	Table A-22	Table A-15	Table A-29
Waste Water	Table A-23	Table A-16	Table A-30
Communications	Table A-24	Table A-17	Table A-31

Before establishing the anticipated performance for the individual components of the building clusters and infrastructure systems, the affected area and disruption level anticipated for each potential hazard event were estimated at the community level.

For an expected earthquake, the affected area was anticipated to be the community, meaning that while the damage is mostly contained within Riverbend, assistance may be needed from nearby communities. The anticipated disruption level for the expected earthquake was moderate, indicating that critical facilities may be functional, but other systems are likely to only be partially functional. Once these parameters were established, the Riverbend planning team completed the anticipated performance goals. Table A-12 to Table A-17 show Riverbend's performance goals tables with the anticipated performance for the expected earthquake. An X was placed in each row of the performance goals tables by the task groups to indicate the anticipated performance of existing buildings and infrastructure systems given the hazard type and level. The following discusses some of the considerations taken into account when placing some of the X's.

Buildings (Chapter 11 in Volume II). As previously discussed, much of the building stock consists of older construction that used design standards and building codes with typically lower loading criteria. Therefore, when evaluating the risk in Riverbend, the buildings task group determined that a significant portion of the older infrastructure would have to be retrofit to resist seismic loads associated with an expected earthquake, or rebuilt or demolished and replaced after the earthquake, which could take years, as seen in Table A-12.

Table A-12: Riverbend, USA building performance goals for expected earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Expected
	Affected Area	Community
	Disruption Level	Moderate

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	**(4) Support Needed**	**Overall Recovery Time for Hazard and Level Listed Expected Hazard Level**								
		Phase 1 – Short-Term			**Phase 2 -- Intermediate**			**Phase 3 – Long-Term**		
		Days			**Wks**			**Mos**		
		0	**1**	**1-3**	**1-4**	**4-8**	**8-12**	**4**	**4-24**	**24+**
Critical Facilities	….									
Emergency Operation Centers	R, S, MS	90%							X	
First Responder Facilities	R, S, MS	90%							X	
Memorial Hospital	R, S, MS	90%							X	
Non-ambulatory Occupants (prisons, nursing homes, etc.)	R, S, MS	90%							X	
National Aircraft Parts Factory (NAP)	R, S, C	90%							X	
Emergency Housing										
Temporary Emergency Shelters	R, S	30%	90%							X
Single and Multi-family Housing (Shelter in place)	R, S	60%			90%					X
Housing/Neighborhoods										
Critical Retail	R, S, C		30%	60%	90%					X
Religious and Spiritual Centers	R, S			30%	60%	90%				X
Single and Multi-family Housing (Full Function)	R, S			30%		60%		90%		X
Schools	R, S			30%	60%	90%				X
Hotels & Motels	R, S, C			30%		60%	90%			X
Community Recovery										
Businesses – Manufacturing (except NAP)	R, S, C				30%	60%	90%			X
Businesses - Commodity Services	R, S, C				30%	60%		90%		X
Businesses - Service Professions	R, S, C				30%		60%		90%	X
Conference & Event Venues	R, S, C				30%		60%		90%	X

Footnotes:

1 Specify hazard being considered
Specify level -- Routine, Expected, Extreme
Specify the size of the area affected - localized, community, regional
Specify severity of disruption - minor, moderate, severe

2 30% 60%

3 X Estimated restoration time for current conditions based on design standards and current inventory
Relates to each cluster or category and represents the level of restoration of service to that cluster or category
Listing for each category should represent the full range for the related clusters
Category recovery times will be shown on the Summary Matrix
"X" represents the recovery time anticipated to achieve a 90% recovery level for the current conditions

4 Indicate levels of support anticipated by plan
R Regional
S State
MS Multi-state
C Civil Corporate Citizenship

Transportation (Chapter 12 in Volume II). Riverbend's transportation system consisted mostly of local roads, as previously discussed. The transportation task group estimated that, though some of the local roads would be damaged due to cracking in the roads and/or their foundations, the transportation system would be mostly functional within 2 weeks (indicated as 1-4 weeks in Table A-13). The task group was concerned that there could be some damage to the highway bridge crossing Central River, but it would be and all lanes would be open (i.e., fully operational) within one month. This bridge is important to the community since it is the only crossing of Central River.

Table A-13: Riverbend, USA transportation infrastructure performance goals for expected earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Expected
	Affected Area	Community
	Disruption Level	Moderate

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	**(4) Support Needed**	**Overall Recovery Time for Hazard and Level Listed Expected Hazard Level**								
		Phase 1 – Short-Term			**Phase 2 -- Intermediate**			**Phase 3 – Long-Term**		
		Days			**Wks**			**Mos**		
		0	**1**	**1-3**	**1-4**	**4-8**	**8-12**	**4**	**4-24**	**24+**
Ingress (goods, services, disaster relief)										
Local Roads	R, S	60%	90%	X						
State Highways and Bridge	R, S	60%	90%		X					
Regional Airport	R, S		30%	60%	90%		X			
Egress (emergency egress, evacuation, etc)										
Local Roads	R, S	60%	90%	X						
State Highways and Bridge	R, S	60%	90%		X					
Regional Airport	R, S		30%	60%	90%		X			
Community resilience										
Critical Facilities										
Hospitals	R, S	60%	90%	X						
Police and Fire Stations	R, S	60%	90%	X						
Emergency Operational Centers	R, S	60%	90%	X						
Emergency Housing										
Residences	R, S	30%	60%	90%	X					
Emergency Responder Housing	R, S	30%	60%	90%	X					
Public Shelters	R, S	90%		X						
Housing/Neighborhoods										
Essential City Service Facilities	R, S	30%	60%	90%	X					
Schools	R, S	30%	60%	90%	X					
Medical Provider Offices	R, S	30%	60%	90%	X					
Retail	R, S	30%	60%	90%	X					
Community Recovery										
Residences	R, S	30%	60%	90%	X					
Neighborhood retail	R, S	30%	60%	90%	X					
Offices and work places	R, S	30%	60%	90%	X					
Non-emergency City Services	R, S	30%	60%	90%	X					
All businesses	R, S		30%	60%	90%	X				

See footnotes on Table A-12, page 59.

Energy (Chapter 13 in Volume II). As seen in Table A-14, electric energy infrastructure performed well in past hazard events. Therefore, the X's are close to the performance goals set by the planning team. There was still room for improvement, however. Specifically, improving the resilience of the system would be helpful to ensure that the community did not go over one week without commercial power.

Table A-14: Riverbend, USA energy infrastructure performance goals for expected earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Expected
	Affected Area	Community
	Disruption Level	Moderate

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Expected Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Power - Electric Utilities										
Bulk Generation										
Renewable, Non-Variable (Hydro, Biomass, Geothermal, Pump Storage)	R/C	90%	X							
Transmission (including Substations)										
Critical Response Facilities and Support Systems										
Hospitals, Police and Fire Stations / Emergency Operations Centers	R, C	90%	X							
Disaster debris / recycling centers/ related lifeline systems	R, C	60%	90%	X						
Emergency Housing and Support Systems										
Public Shelters / Nursing Homes / Food Distribution Centers	R, C	60%	90%	X						
Emergency shelter for response / recovery workforce/ Key Commercial and Finance	R, C		60%	90%	X					
Housing and Neighborhood infrastructure										
Essential city services / schools / Medical offices	R, C		60%	90%	X					
Houses of worship/meditation/ exercise	C		60%	90%	X					
Buildings/space for social services (e.g., child services) and prosecution activities	C		60%	90%	X					
Community Recovery Infrastructure										
Commercial and industrial businesses / Non-emergency city services	C			60%	90%	X				
Residential housing restoration	R, S, MS, C			60%	90%	X				
Distribution										
Critical Response Facilities and Support Systems										
Hospitals, Police and Fire Stations / Emergency Operations Centers	R, C	60%	90%	X						
Disaster debris / recycling centers/ related lifeline systems	R, C	60%	90%	X						
Emergency Housing and Support Systems										
Public Shelters / Nursing Homes / Food Distribution Centers	R, C		60%	90%	X					
Emergency shelter for response / recovery workforce/ Key Commercial and Finance	R, C		60%	90%	X					
Housing and Neighborhood infrastructure										
Essential city services / schools / Medical offices	R, C		60%	90%	X					
Houses of worship/meditation/ exercise	C		60%	90%	X					
Buildings/space for social services (e.g., child services) and prosecution activities	C		60%	90%	X					
Community Recovery Infrastructure										
Commercial and industrial businesses / Non-emergency city services	C			90%	X					
Residential housing restoration	R, S, MS, C			90%	X					

See footnotes on Table A-12, page 59.

Water (Chapter 15 in Volume II). Similar to transportation, the main concern of the water and wastewater task group was that the bridge crossing Central River was a single-point-of-failure for clean water coming into Riverbend from Fallsborough. The task group, based on past earthquake events in the region, experience, and expert judgment, estimated that there would be some damage to the water main crossing the bridge in an expected earthquake. Therefore, repairing/replacing the water main and ensuring water quality standards were met could take months as indicated by the X's shown in Phase 3 of Table A-15.

Table A-15: Riverbend, USA water infrastructure performance goals for expected earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Expected
	Affected Area	Community
	Disruption Level	Moderate

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Expected Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Source										
Raw or source water and terminal reservoirs	R, S			90%						
Raw water conveyance (pump stations and piping to WTP)	R, S				90%				X	
Potable water at supply (WTP, wells, impoundment)	R, S	30%		60%	90%			X		
Water for fire suppression at key supply points (to promote redundancy)	R, S	90%			X					
Transmission (including Booster Stations)										
Backbone transmission facilities (pipelines, pump stations, and tanks)	R, S	90%					X			
Control Systems										
SCADA or other control systems	R, S	30%		60%	90%		X			
Distribution										
Critical Facilities										
Wholesale Users (other communities, rural water districts)	R, S		60%	90%			X			
Hospitals, EOC, Police Station, Fire Stations	R, S		60%	90%			X			
Emergency Housing										
Emergency Shelters	R, S		60%	90%			X			
Housing/Neighborhoods										
Drink water available at community distribution centers	R, S			60%	90%					
Water for fire suppression at fire hydrants	R, S				90%				X	
Community Recovery Infrastructure										
All other clusters	R, S			30%	90%				X	

See footnotes on Table A-12, page 59.

Wastewater (Chapter 15 in Volume II). The water and wastewater task group estimate that an expected earthquake would cause significant damage to the wastewater treatment plant, and it would take months for repairs to the infrastructure to be completed, as indicated in Table A-16. However, the task group did note that they would have some functionality in the intermediate recovery phase that should be sufficient for the community to continue functioning.

Table A-16: Riverbend, USA wastewater infrastructure performance goals for expected earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Expected
	Affected Area	Community
	Disruption Level	Moderate

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Expected Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Treatment Plants										
Treatment plants operating with primary treatment and disinfection	R, S			60%	90%				X	
Treatment plants operating to meet regulatory requirements	R, S				30%			60%	90%	X
Trunk Lines										
Backbone collection facilities (major trunkline, lift stations, siphons, relief mains, aerial crossings)	R, S			30%		60%	90%			X
Flow equalization basins	R, S			30%		60%	90%			X
Control Systems										
SCADA and other control systems	R, S				30%		60%	90%		X
Collection Lines										
Critical Facilities										
Hospitals, EOC, Police Station, Fire Stations	R, S			30%	90%				X	
Emergency Housing										
Emergency Shelters	R, S			30%	90%				X	
Housing/Neighborhoods										
Threats to public health and safety controlled by containing & routing raw sewage away from public	R, S		30%		60%	90%			X	
Community Recovery Infrastructure										
All other clusters	R, S				30%		60%		90%	X

See footnotes on Table A-12, page 59.

Communications (Chapter 14 in Volume II). The communication task group stated that the performance goals set in Table A-17 were aggressive, and local providers would not be able to meet them yet. Overall, the group found that the communications infrastructure performed well, partly because there was a significant amount of redundancy in the network. Again, based on discussions with the service providers in Riverbend, USA, the regional Central Office (outside of the community) was anticipated to be fully functional about 2 weeks after an expected earthquake (indicated as 1-4 weeks in Table A-17). Though it was anticipated that the last mile for much of Riverbend would not be fully functional until 8-12 weeks after an expected earthquake, the task group also noted that the local service providers were already undertaking efforts that would result in performance being more in-line with the goals shown in the table.

Table A-17: Riverbend, USA communications infrastructure performance goals for expected earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Expected
	Affected Area	Community
	Disruption Level	Moderate

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Expected Hazard Level								
		Phase 1 – Short-Term			Phase 2 – Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-36	36+
Core and Communications Buildings										
Central Offices	R, S, C	90%			X					
Buildings containing exchanges	R, S, C	90%			X					
Distribution Hubs										
Free standing cell phone towers	R, S, C	90%			X					
Last Mile										
Critical Facilities										
Hospitals	R, S, C	90%			X					
Police and fire stations	R, S, C	90%			X					
Emergency Operation Center	R, S, C	90%			X					
Emergency Housing										
Residences	R, S, C			60%	90%		X			
Emergency responder housing	R, S, C			60%	90%		X			
Public Shelters	R, S, C			60%	90%		X			
Housing/Neighborhoods										
Essential city service facilities	R, S, C			30%	90%		X			
Schools	R, S, C			30%	90%		X			
Medical provider offices	R, S, C			30%	90%		X			
Retail	R, S, C			30%	90%			X		
Community Recovery Infrastructure										
Residences	R, S, C			30%	90%		X			
Neighborhood retail	R, S, C			30%	90%			X		
Offices and work places	R, S, C			30%	90%		X			
Non-emergency city services	R, S, C			30%	90%			X		
Businesses	R, S, C			30%	90%			X		

See footnotes on Table A-12, page 59.

A.4.5. Summarize the Results (Section 4.1.5 of the Guide)

Develop Summary Matrices. The planning team developed performance goals matrices that summarized the performance goals for each infrastructure system and buildings. Developing the summary matrices was helpful because the planning team could identify the dependencies between the infrastructure systems and buildings for each building cluster. These dependencies, along with the resilience gaps identified within the individual buildings and infrastructure systems helped the planning team make informed decisions about what investments in their infrastructure would best address their resilience.

To complete the resilience matrix (Table A-18), the worst case performance goals value (90%) and anticipated performance (X) from that cluster in the detailed performance goals tables (to Table A-17) were used.

Table A-18: Riverbend, USA resilience matrix expected earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Expected
	Affected Area	Community
	Disruption Level	Moderate

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	Overall Recovery Time for Hazard and Level Listed Expected Hazard Level								
	Phase 1 – Short-Term			Phase 1 – Short-Term			Phase 1 – Short-Term		
	Days	Days	Days	Wks	Wks	Wks	Mos	Mos	Mos
	0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Critical Facilities									
Buildings	90%							X	
Transportation		90%	X						
Energy		90%	X						
Water			90%		X				
Waste Water				90%				X	
Communication	90%			X					
Emergency Housing									
Buildings				90%					X
Transportation			90%	X					
Energy			90%	X					
Water			90%		X				
Waste Water				90%				X	
Communication				90%	X				
Housing/Neighborhoods									
Buildings						90%			X
Transportation			90%	X					
Energy			90%	X					
Water				90%				X	
Waste Water					90%			X	
Communication				90%			X		
Community Recovery									
Buildings								90%	X
Transportation				90%	X				
Energy			90%	X					
Water				90%				X	
Waste Water							90%	X	
Communication				90%			X		

See footnotes on Table A-12, page 59.

A.4.6. Repeat Process for Each Hazard Type and Level

As previously stated, the process of developing a community resilience plan was completed for each hazard type and level. The previous text in this section reflects the process used and specifics regarding the Riverbend, USA expected earthquake event. However, performance goals tables for the routine earthquake and extreme flood events are also included as listed in Table A-11 (page 58).

Routine Earthquake. Riverbend's planning team was planning with the expected event in mind from the design and mitigation standpoint. Therefore, when considering the routine event, it was desired that there be little or no disruption to the building clusters or supporting infrastructure systems. As seen in Table A-19 to Table A-24, for a routine earthquake event, the performance goals were mostly shifted to the left (i.e., shorter recovery time) as a result. The anticipated performance for the routine event was also estimated to be much better than for the expected event, with very little damage to buildings likely to occur.

As was done for the expected earthquake event, the summary matrix, shown in Table A-25, was completed after all of the task groups completed the detailed tables (Table A-19 to Table A-24) to understand the overall impacts on Riverbend's buildings and infrastructure systems. As seen in Table A-25, only a limited amount of disruption was anticipated, but it did not quite meet the goals for which the planning team was striving to achieve.

Extreme Flood. As discussed earlier, the Riverbend hazards task group found that much of the community would be vulnerable to an extreme flood event. Unlike the expected and routine events, the performance goals were established for recovery planning rather than design and mitigation planning. This was done because it would not be economically feasible to design all buildings and infrastructure for the extreme event in Riverbend such that there would be limited damage. However, design and mitigation strategies would be used to achieve the performance goals for critical infrastructure, such as the bridge crossing the Central River. Table A-26 to Table A-31 in Section A.9 show the detailed performance goals and anticipated performance of the building clusters and infrastructure systems for the extreme flood in Riverbend, USA. Table A-32 shows the summary matrix of the performance goals. As one would anticipate, the performance goals and anticipated performance for the extreme event are mostly shifted to the right (i.e., longer recovery times) from the expected earthquake event.

A.5. Plan Development (Chapter 5 of the Guide)

Evaluate Gaps Between Desired and Anticipated Performance. Once the performance goals tables were filled out by the task groups, the resilience gaps (i.e., difference between the anticipated performance, "X," and the 90% performance goals) were identified. As can be seen in Table A-18 (as well as Table A-25 and Table A-32), buildings had some of the largest resilience gaps, and therefore it was clear that something needed to be done to improve the performance of buildings in Riverbend. Water was also another large resilience gap in the summary tables, and since clean water is essential for almost any community, it would likely need to be addressed.

Based on the community priorities previously set, the planning team then worked with the task groups to identify which long-term investments would be most valuable in making Riverbend more resilient. Identifying these resilience gaps led to the implementation of a resilience strategy over the long-term.

Identify Solutions to Address Gaps. During plan development, the planning team considered many projects that could be funded in the long-term (over a 50-year period) to achieve the community goals listed at the start of the previous section. Because many of the larger investments required more resources than currently available to the planning team, and would have to, therefore, be implemented over decades, the planning team also worked with the task groups to identify short-term solutions that could be implemented. The following lists the construction and administrative solutions developed by Riverbend's seven tasks groups, as recommendations to the planning team.

New Construction Solutions

Transportation – Highway Bridge. The single highway bridge passing over the Central River from Riverbend to Fallsborough was identified by the planning team as critical infrastructure to the community. Its failure would result in significant disruptions to commuters, and trucks transporting goods since the nearest bridge was 10 miles away. Since the bridge also carried the water line from the Fallsborough Water Treatment Plant into Riverbend, failure of the bridge would also sever the one source of drinking water for Riverbend.

Since the bridge was old and had not been updated to meet more modern bridge design standards, the bridge was determined to be vulnerable to an expected earthquake and extreme flood. Therefore, the planning team asked the transportation task group to recommend potential solutions to address this vulnerability. The task group responded with a number of potential solutions, and proposed the following recommendation to the planning team:

1. Work with the State DOT to seek support for a second bridge crossing. The second crossing would relieve congestion during high traffic periods when traffic volume exceeds the capacity of the bridge, and provide additional water supply that would benefit Riverbend's long-term development plans. By adding a second crossing, it would also provide redundancy to the transportation and water systems, eliminating a single point of failure in each system.
2. Since the existing bridge was scheduled (and budgeted) to undergo a deck replacement in ten years, there was an opportunity to complete a seismic upgrade. However, the transportation task group completed a cost benefit analysis of completing a seismic upgrade and raising the bridge, and compared it to constructing a new bridge at a higher elevation to address the concern of an extreme flood. The task group found that it was more practical and economical to construct a new bridge at a higher elevation. Therefore, they elected to recommend the construction of a new bridge at a higher elevation.

Wastewater/Businesses – Flood Protection Levee. The wastewater treatment plant and the National Aircraft Parts (NAP) plant were both in the flood plain. NAP is a major employer in the community, employing over 3,000 people. With NAP being such a large employer, it was important to the community that NAP remain in Riverbend. The planning team worked with the water and wastewater, and hazards task groups to identify potential solutions to limit the vulnerability of these two facilities to flooding. Based upon the findings of the task groups, they recommended the following solution to the planning team:

1. Partner with the State to pursue a Pre-Disaster Mitigation program grant to build a flood control levee to protect both facilities.

Existing Construction Solutions

Water Supply. As previously discussed, the single bridge crossing Central River between Riverbend and Fallsborough carried the single water main into Riverbend. Since the solutions recommended to the planning team to add an additional bridge and make upgrades to the existing bridge were long-term solutions, the water and wastewater task group advocated for the following short-term solution so that Riverbend residents would have clean water in the case that a disaster struck before these solutions could be implemented:

1. Three wells that had been used historically in Riverbend had not been used in years when the Fallsborough Water Utility began supplying water to Riverbend. The city could restore these wells to provide a redundant water supply in the event the bridge crossing was lost prior to the second water main being provided via the future bridge.

Long-Term Administrative Solutions

Buildings Downtown. As previously discussed, the downtown district is very important to the community. Parts of the downtown area, which were less prone to flooding, have been well-preserved and in turn, have flourished in recent years as restaurants and shops had moved in. However, part of the downtown experienced frequent flooding and had begun to languish as a result. Small businesses in this part of town struggled and the residents of this part of town were generally lower-income residents. The planning team worked with the social dimensions, hazards and buildings task groups to determine if the well-preserved part of downtown and their residents were subject to risks from more severe hazards events than recently experienced by Riverbend. The task groups found that the buildings in the area were vulnerable to an expected flood and vulnerable to collapse in an expected earthquake. Therefore, the task groups made the following recommendations to the planning team:

1. The city government would undertake buy-back programs, including:
   - The city government would undertake a buy-back program for houses in the part of the downtown district that were in the zone most vulnerable to flooding and in a state of disrepair. It was also suggested that the City undertake a program to assist these residents with relocation to less vulnerable parts of the city and into buildings or houses that were less vulnerable to collapse due to earthquake.
   - The city would undertake a program to buy back commercial properties in the downtown district and assist business owners with relocation to other parts of the city. This would give these business owners the opportunity to increase traffic and prevent struggling businesses from failing, which would contribute to stabilizing employment and economic growth.
   - The properties bought back by the City would be razed and the land used to create a city-owned golf course. The golf course would provide jobs for management, food services, grounds keeping/maintenance. It would also provide a source of entertainment for residents, and additional income to Riverbend, while allowing a spillway for floods.
2. The City would work with building and business owners in the downtown district to implement a seismic retrofit program improve the performance of older, earthquake-vulnerable buildings.

Energy – Critical Facilities and Government Offices. The energy task group developed the following solution that would ensure that government offices and critical facilities could continue operation during and immediately following a disruptive event or return to service quickly:

1. Develop an energy assurance plan to ensure police and fire stations, government offices, and critical facilities had sufficient power to allow them to operate at full capacity until grid power could be restored. The energy task group would form a team with the regional electric utility to implement cost-effective measures to achieve the energy assurance goals.

Short-Term Administrative Solutions

Communications – Charging Stations. The communications task group was concerned that the last mile of the communications infrastructure system may be impacted by an expected event (i.e., earthquake or flood). They worked with service providers to come up with potential solutions. Based upon their discussions, the following solution was recommended:

1. The city would purchase charging stations for cellular phones and deploy them in the aftermath of a disaster event where external power is lost. These stations are commonly imported by service providers after disaster events. However, if the highway bridge experiences a disruption in service, it will be difficult to import charging stations.

Prioritize Solutions and Develop Implementation Strategy. As can be seen, a number of expensive and long-term resilience solutions were recommended to the planning team by the task groups . The planning team worked together with the task groups to prioritize these solutions to develop an implementation strategy over 50 years, based partly on the relative benefits each solution offered. The proposed strategy and schedule were defined as:

1. The City Council will purchase charging stations that could be deployed in the days following a disaster event as well as used at community events throughout the year. This will occur within 6 months of implementation of the resilience plan.
2. The buy-back programs will take place over decades. Therefore, the City Council will initiate the program within two years, and plan for it to take place over 25-30 years. They were interested in accelerating the buy-back programs, but did not have the resources to do so.
   - Addition of the golf course replacing these areas will be completed over the same time period, with the revitalization plan to be completed in 40-50 years. The money earned from the golf course will go towards implementing other future strategies to make Riverbend more resilient.
3. The City will work with the State to apply for a FEMA Pre-Disaster Mitigation (PDM) program grant. Since Rockyside, located in the same state, had been impacted by a recent event, the state was interested in applying for the grant.
4. Riverbend plans to restore the existing three wells to provide a redundant water service to be used in the case of a disaster event or water shortage. To inspect, test, and retain the appropriate permits and approvals is anticipated to take 3-5 years.
5. Implementing an energy assurance plan can be done fairly quickly, but it is not the highest priority because the energy system performed well in past flood and earthquake events in the region. As a result, the City Council plans to implement this solution in 5-10 years.
6. The City Council will engage with the State DOT to advocate for a new bridge to provide additional capacity for high traffic volume. This would also add redundancy of the transportation and water systems, and support regional growth. The new bridge should be completed within 5-10 years since replacement of the existing bridge is scheduled to take place in 10 years.
7. Riverbend also plans to replace the existing bridge. The replacement bridge will be constructed at a higher elevation to address the concern of the extreme flood. However, resources are limited. To ensure the resources are available, the bridge deck replacement scheduled for 10 years in the future is extended to 15 years.
8. The city will develop incentives to encourage business owners in the downtown area to implement seismic retrofits and work with them to do so. This program received a lower priority due to limited resources and is planned to be initiated in 10-15 years, with the intent to complete the program within 30 years.

A.6. Plan Preparation, Review, and Approval (Chapter 6 of the Guide)

After the task groups proposed solutions to the planning team, they worked together to draft a resilience plan to submit to the Riverbend City Council. The plan contained the original resilience goals and the draft implementation strategy discussed in the previous section, as well as all supporting information that was developed as part of planning steps 1 through 4. Supporting information was included in Riverbend's draft resilience plan:

- Summary report characterizing the social dimensions of Riverbend
- Summary report characterizing the built environment of Riverbend
- Tables and associated text that describe the linkages between the built and social environments
- A list of the long-term community goals and associated metrics
- Summary report defining Riverbend's hazards and hazard levels

- Performance matrices and associated text explaining the Riverbend's desired performance goals for the built environment for each hazard level and the anticipated performance of the built environment for each hazard and hazard level
- Summary matrices and associated text, including identification of the dependencies among buildings and infrastructure systems and the gaps between desired and anticipated performance
- The list of construction and administrative solutions developed by Riverbend to address gaps in performance.
- Proposed prioritization and scheduling of implementation of the resilience strategies.

Once the plan was developed, the planning team publicized the plan's release and also formally opened a 60-day public comment period to collect input from additional stakeholders. To engage the community, the planning team organized two community City Hall meetings, two weeks apart during the first month of the plan's release, which allowed members of Riverbend to provide their comments on the plan. Additionally, the planning team members disseminated the draft plan to all task group members, allowing them to distribute the plan throughout their organizations, departments, and agencies for review. The planning team, after the public comment period, finalized Riverbend's resilience plan and submitted it to the City Council for approval. Riverbend received notice of the plan's approval once it was signed by the Mayor.

A.7. Plan Implementation and Maintenance (Chapter 6 of the Guide)

Once the plan was approved, Riverbend began the implementation process. Certain solutions within the strategy, especially the shorter-term solutions, began right away. For example, Riverbend began contacting vendors to inquire about bulk purchasing of charging stations for cellular phones. They were able to purchase these charging stations at a bulk rate within 4 months of initiating the implementation of the resilience strategy (two months less than their anticipated time frame).

Riverbend also began engagement in some of the longer-term solutions, since they required initial efforts to begin the process of implementation. For example, within the first 6 months of initiating the implementation plan, Riverbend and Rockyside worked with the State to apply for a FEMA Pre-Disaster Mitigation (PDM) program grant. The deadline for the first funding cycle was missed by the time Riverbend's plan was finalized. However, they were successful in attaining funding for construction of the flood control levee during year two of the implementation (first time they applied).

Throughout the implementation of their resilience plan, Riverbend decided to track all progress and post it publically on their city's website. Riverbend also decided to review their resilience plan on an annual basis and assess whether the implementation strategy or any specific solutions within that strategy required modification.

A.8. Routine Earthquake Performance Goals Tables

Table A-19: Riverbend, USA buildings performance goals for routine earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Routine
	Affected Area	Localized
	Disruption Level	Usual

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Routine Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Critical Facilities	**….**									
Emergency Operation Centers	R, S, MS	90%	X							
First Responder Facilities	R, S, MS	90%	X							
Acute Care Hospitals	R, S, MS	90%	X							
Non-ambulatory Occupants (prisons, nursing homes, etc.)	R, S, MS	90%	X							
National Aircraft Parts Factory (NAP)	R, S, C									
Emergency Housing										
Temporary Emergency Shelters	R, S	90%		X						
Single / Multi-family Housing (Shelter in place)	R, S	90%		X						
Housing/Neighborhoods										
Critical Retail	R, S, C	90%		X						
Religious and Spiritual Centers	R, S	90%		X						
Single and Multi-family Housing (Full Function)	R, S	90%		X						
Schools	R, S	90%		X						
Hotels & Motels	R, S, C	90%		X						
Community Recovery										
Businesses – Manufacturing (except NAP)	R, S, C	60%	90%	X						
Businesses - Commodity Services	R, S, C	60%	90%	X						
Businesses - Service Professions	R, S, C	60%	90%	X						
Conference & Event Venues	R, S, C	60%	90%	X						

See footnotes on Table A-12, page 59.

Table A-20: Riverbend, USA transportation infrastructure performance goals for routine earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Routine
	Affected Area	Localized
	Disruption Level	Usual

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	**(4) Support Needed**	**Overall Recovery Time for Hazard and Level Listed Routine Hazard Level**								
		Phase 1 – Short-Term			**Phase 2 -- Intermediate**			**Phase 3 – Long-Term**		
		Days			**Wks**			**Mos**		
		0	**1**	**1-3**	**1-4**	**4-8**	**8-12**	**4**	**4-24**	**24+**
Ingress (goods, services, disaster relief)										
Local Roads	R, S	90%	X							
State Highways and Bridge	R, S	90%	X							
Regional Airport	R, S	60%	90%	X						
Egress (emergency egress, evacuation, etc)										
Local Roads	R, S	90%	X							
State Highways and Bridge	R, S	90%	X							
Regional Airport	R, S	60%	90%	X						
Community resilience										
Critical Facilities										
Hospitals	R, S	90%	X							
Police and Fire Stations	R, S	90%	X							
Emergency Operational Centers	R, S	90%	X							
Emergency Housing										
Residences	R, S	90%	X							
Emergency Responder Housing	R, S	90%	X							
Public Shelters	R, S	90%	X							
Housing/Neighborhoods										
Essential City Service Facilities	R, S	60%	90%	X						
Schools	R, S	60%	90%	X						
Medical Provider Offices	R, S	60%	90%	X						
Retail	R, S	60%	90%	X						
Community Recovery										
Residences	R, S	60%	90%	X						
Neighborhood retail	R, S	60%	90%	X						
Offices and work places	R, S	60%	90%	X						
Non-emergency City Services	R, S	60%	90%	X						
All businesses	R, S	30%	60%	90%	X					

See footnotes on Table A-12, page 59.

Table A-21: Riverbend, USA energy infrastructure performance goals for routine earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Routine
	Affected Area	Localized
	Disruption Level	Usual

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Routine Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Power - Electric Utilities										
Bulk Generation										
Renewable, Non-Variable (Hydro, Biomass, Geothermal, Pump Storage)	R, S, MS	90%								
Transmission (including Substations)										
Critical Response Facilities and Support Systems										
Hospitals, Police and Fire Stations / Emergency Operations Centers	R, C	90%								
Disaster debris / recycling centers/ Related lifeline systems	R, C	90%								
Emergency Housing and Support Systems										
Public Shelters / Nursing Homes / Food Distribution Centers	R, C	90%								
Emergency shelter for response / recovery workforce/ Key Commercial and Finance	R, C	90%								
Housing and Neighborhood infrastructure										
Essential city services facilities / schools / Medical offices	R, C	90%	X							
Houses of worship/meditation/ exercise	C	90%	X							
Buildings/space for social services (e.g., child services) and prosecution activities	C	90%	X							
Community Recovery Infrastructure										
Commercial and industrial businesses / Non-emergency city services	C	90%	X							
Residential housing restoration	R, S, MS, C	90%	X							
Distribution										
Critical Response Facilities and Support Systems										
Hospitals, Police and Fire Stations / Emergency Operations Centers	R, C	90%	X							
Disaster debris / recycling centers/ Related lifeline systems	R, C	90%	X							
Emergency Housing and Support Systems										
Public Shelters / Nursing Homes / Food Distribution Centers	R, C	90%	X							
Emergency shelter for response / recovery workforce/ Key Commercial and Finance	R, C	90%	X							
Housing and Neighborhood infrastructure										
Essential city services facilities / schools / Medical offices	R, C		90%	X						
Houses of worship/meditation/ exercise	C		90%	X						
Buildings/space for social services (e.g., child services) and prosecution activities	C		90%	X						
Community Recovery Infrastructure										
Commercial and industrial businesses / Non-emergency city services	C		90%	X						
Residential housing restoration	R, S, MS, C		90%	X						

See footnotes on Table A-12, page 59.

Table A-22: Riverbend, USA water infrastructure performance goals for routine earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Routine
	Affected Area	Localized
	Disruption Level	Usual

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Routine Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Source										
Raw or source water and terminal reservoirs	R, S	90%		X						
Raw water conveyance (pump stations and piping to WTP)	R, S	90%		X						
Potable water at supply (WTP, wells, impoundment)	R, S	90%		X						
Water for fire suppression at key supply points (to promote redundancy)	R, S	90%		X						
Transmission (including Booster Stations)										
Backbone transmission facilities (pipelines, pump stations, and tanks)	R, S	90%		X						
Control Systems										
SCADA or other control systems	R, S	90%		X						
Distribution										
Critical Facilities										
Wholesale Users (other communities, rural water districts)	R, S	90%		X						
Hospitals, EOC, Police Station, Fire Stations	R, S	90%		X						
Emergency Housing										
Emergency Shelters	R, S	90%		X						
Housing/Neighborhoods										
Drink water available at community distribution centers	R, S		90%		X					
Water for fire suppression at fire hydrants	R, S		90%		X					
Community Recovery Infrastructure										
All other clusters	R, S			90%	X					

See footnotes on Table A-12, page 59.

Table A-23: Riverbend, USA wastewater infrastructure performance goals for routine earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Routine
	Affected Area	Localized
	Disruption Level	Usual

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Routine Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Treatment Plants										
Treatment plants operating with primary treatment and disinfection	R, S			90%	X					
Treatment plants operating to meet regulatory requirements	R, S			90%	X					
Trunk Lines										
Backbone collection facilities (major trunkline, lift stations, siphons, relief mains, aerial crossings)	R, S		60%	90%	X					
Flow equalization basins	R, S		60%	90%	X					
Control Systems										
SCADA and other control systems	R, S	90%		X						
Collection Lines										
Critical Facilities										
Hospitals, EOC, Police Station, Fire Stations	R, S		90%	X						
Emergency Housing										
Emergency Shelters	R, S		90%	X						
Housing/Neighborhoods										
Threats to public health and safety controlled by containing & routing raw sewage away from public	R, S		60%	90%	X					
Community Recovery Infrastructure										
All other clusters	R, S		60%	90%	X					

See footnotes on Table A-12, page 59..

Table A-24: Riverbend, USA communications performance goals for routine earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Routine
	Affected Area	Localized
	Disruption Level	Usual

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Routine Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-24	24+
Core and Communications Building										
Central offices	R, S, C	90%		X						
Buildings containing exchanges	R, S, C	90%		X						
Distribution Hubs										
Free standing cell phone towers	R, S, C	90%		X						
Last Mile										
Critical Facilities										
Hospitals	R, S, C	90%		X						
Police and fire stations	R, S, C	90%		X						
Emergency operation center	R, S, C	90%		X						
Emergency Housing										
Residences	R, S, C	90%			X					
Emergency responder housing	R, S, C	90%			X					
Public shelters	R, S, C	90%			X					
Housing/Neighborhoods										
Essential city service facilities	R, S, C	60%	90%		X					
Schools	R, S, C	60%	90%		X					
Medical provider offices	R, S, C	60%	90%		X					
Retail	R, S, C	60%	90%		X					
Community Recovery Infrastructure										
Residences	R, S, C	60%	90%		X					
Neighborhood retail	R, S, C	60%	90%		X					
Offices and work places	R, S, C	60%	90%		X					
Non-emergency city services	R, S, C	60%	90%		X					
Businesses	R, S, C	60%	90%		X					

See footnotes on Table A-12, page 59..

Table A-25: Riverbend, USA summary resilience matrix for routine earthquake

Disturbance		
(1)	Hazard	Earthquake
	Hazard Level	Routine
	Affected Area	Localized
	Disruption Level	Usual

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	**Overall Recovery Time for Hazard and Level Listed Routine Hazard Level**								
	Phase 1 – Short-Term			**Phase 2 -- Intermediate**			**Phase 3 – Long-Term**		
	Days	**Days**	**Days**	**Wks**	**Wks**	**Wks**	**Mos**	**Mos**	**Mos**
	0	**1**	**1-3**	**1-4**	**4-8**	**8-12**	**4**	**4-24**	**24+**
Critical Facilities									
Buildings	90%	X							
Transportation	90%	X							
Energy	90%	X							
Water	90%		X						
Waste Water		90%	X						
Communication	90%		X						
Emergency Housing									
Buildings	90%		X						
Transportation	90%	X							
Energy	90%	X							
Water	90%		X						
Waste Water		90%	X						
Communication	90%			X					
Housing/Neighborhoods									
Buildings	90%		X						
Transportation		90%	X						
Energy		90%	X						
Water		90%		X					
Waste Water			90%	X					
Communication		90%		X					
Community Recovery									
Buildings		90%	X						
Transportation			90%	X					
Energy		90%	X						
Water			90%	X					
Waste Water			90%	X					
Communication		90%		X					

See footnotes on Table A-12, page 59.

A.9. Extreme Flood Performance Goals Tables

Table A-26: Riverbend, USA building performance goals for extreme flood

Disturbance		
(1)	Hazard	Flood
	Hazard Level	Extreme
	Affected Area	Regional
	Disruption Level	Severe

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	**(4) Support Needed**	**Overall Recovery Time for Hazard and Level Listed Extreme Hazard Level**								
		Phase 1 – Short-Term			**Phase 2 -- Intermediate**			**Phase 3 – Long-Term**		
		Days			**Wks**			**Mos**		
		0	**1**	**1-3**	**1-4**	**4-8**	**8-12**	**4**	**4-36**	**36+**
Critical Facilities										
Emergency Operation Centers	R, S, MS	90%								X
First Responder Facilities	R, S, MS	90%								X
Acute Care Hospitals	R, S, MS	30%		60%		90%				X
Non-ambulatory Occupants (prisons, nursing homes, etc.)	R, S, MS	30%			60%		90%			X
Anything Aircrafts Part Factory (NAP)	R, S, C	30%			60%		90%			X
Emergency Housing										
Temporary Emergency Shelters	R, S	30%		60%	90%					X
Single and Multi-family Housing (Shelter in place)	R, S	30%			60%		90%			X
Housing/Neighborhoods										
Critical Retail	R, S, C			30%	60%	90%				X
Religious and Spiritual Centers	R, S			30%		60%	90%			X
Single and Multi-family Housing (Full Function)	R, S				30%		60%	90%		X
Schools	R, S				30%	60%	90%			X
Hotels & Motels	R, S, C				30%		60%	90%		X
Community Recovery										
Businesses – Manufacturing (except NAP)	R, S, C				30%		60%		90%	X
Businesses - Commodity Services	R, S, C				30%		60%		90%	X
Businesses - Service Professions	R, S, C					30%		60%	90%	X
Conference & Event Venues	R, S, C					30%		60%	90%	X

See footnotes on Table A-12, page 59.

2478 ***Table A-27: Riverbend, USA transportation infrastructure performance goals for extreme flood***

Disturbance		
(1)	Hazard	Flood
	Hazard Level	Extreme
	Affected Area	Regional
	Disruption Level	Severe

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

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Functional Category: Cluster	**(4) Support Needed**	**Overall Recovery Time for Hazard and Level Listed Extreme Hazard Level**								
		Phase 1 – Short-Term			**Phase 2 -- Intermediate**			**Phase 3 – Long-Term**		
		Days			**Wks**			**Mos**		
		0	**1**	**1-3**	**1-4**	**4-8**	**8-12**	**4**	**4-36**	**36+**
Ingress (goods, services, disaster relief)										
Local Roads	R, S			30%	60%	90%	X			
State Highways and Bridge	R, S			30%	60%	90%	X			
Regional Airport	R, S			30%	60%	90%	X			
Egress (emergency egress, evacuation, etc)										
Local Roads	R, S			30%	60%	90%	X			
State Highways and Bridge	R, S			30%	60%	90%	X			
Regional Airport	R, S			30%	60%	90%	X			
Community resilience										
Critical Facilities										
Hospitals	R, S	30%	60%	90%		X				
Police and Fire Stations	R, S	30%	60%	90%		X				
Emergency Operational Centers	R, S	30%	60%	90%		X				
Emergency Housing										
Residences	R, S			30%	60%	90%	X			
Emergency Responder Housing	R, S	30%	60%	90%	X					
Public Shelters	R, S	30%	60%	90%	X					
Housing/Neighborhoods										
Essential City Service Facilities	R, S			30%	60%	90%	X			
Schools	R, S			30%	60%	90%	X			
Medical Provider Offices	R, S			30%	60%	90%	X			
Retail	R, S			30%	60%	90%	X			
Community Recovery										
Residences	R, S			30%	60%	90%	X			
Neighborhood retail	R, S			30%	60%	90%	X			
Offices and work places	R, S			30%	60%	90%	X			
Non-emergency City Services	R, S			30%	60%	90%	X			
All businesses	R, S			30%	60%	90%	X			

See footnotes on Table A-12, page 59.

Table A-28: Riverbend, USA energy infrastructure performance goals for extreme flood

Disturbance		
(1)	Hazard	Flood
	Hazard Level	Extreme
	Affected Area	Regional
	Disruption Level	Severe

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Extreme Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-36	36+
Power - Electric Utilities										
Bulk Generation										
Renewable, Non-Variable (Hydro, Biomass, Geothermal, Pump Storage)	R/C		90%	X						
Transmission (including Substations)										
Critical Response Facilities and Support Systems										
Hospitals, Police and Fire Stations / Emergency Operations Centers	R, C		60%	90%	X					
Disaster debris / recycling centers/ Related lifeline systems	R, C		60%	90%	X					
Emergency Housing and Support Systems										
Public Shelters / Nursing Homes / Food Distribution Centers	R, C		60%	90%	X					
Emergency shelter for response / recovery workforce/ Key Commercial and Finance	R, C		60%	90%	X					
Housing and Neighborhood infrastructure										
Essential city services facilities / schools / Medical offices	R, C			60%	90%					
Houses of worship/meditation/ exercise	C			60%	90%					
Buildings/space for social services (e.g., child services) and prosecution activities	C			60%	90%					
Community Recovery Infrastructure										
Commercial and industrial businesses / Non-emergency city services	C			60%	90%	X				
Residential housing restoration	R, S, MS, C			60%	90%	X				
Distribution										
Critical Response Facilities and Support Systems										
Hospitals, Police and Fire Stations / Emergency Operations Centers	R, C			60%	90%					
Disaster debris / recycling centers/ Related lifeline systems	R, C			60%	90%					
Emergency Housing and Support Systems										
Public Shelters / Nursing Homes / Food Distribution Centers	R, C			60%	90%					
Emergency shelter for response / recovery workforce/ Key Commercial and Finance	R, C			60%	90%					
Housing and Neighborhood infrastructure										
Essential city services facilities / schools / Medical offices	R, C			60%	90%	X				
Houses of worship/meditation/ exercise	C			60%	90%	X				
Buildings/space for social services (e.g., child services) and prosecution activities	C			60%	90%	X				
Community Recovery Infrastructure										
Commercial and industrial businesses / Non-emergency city services	C			60%	90%	X				
Residential housing restoration	R, S, MS, C			60%	90%	X				

See footnotes on Table A-12, page 59.

Table A-29: Riverbend, USA water infrastructure performance goals for extreme flood

Disturbance		
(1)	Hazard	Flood
	Hazard Level	Extreme
	Affected Area	Regional
	Disruption Level	Severe

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Extreme Hazard Level								
		Phase 1 – Short-Term			Phase 2 – Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-36	36+
Source										
Raw or source water and terminal reservoirs	R, S, MS	30%		60%	90%			X		
Raw water conveyance (pump stations and piping to WTP)	R, S, MS				60%	90%			X	
Potable water at supply (WTP, wells, impoundment)	R, S, MS			30%	60%	90%			X	
Water for fire suppression at key supply points (to promote redundancy)	R, S, MS			90%	X					
Transmission (including Booster Stations)										
Backbone transmission facilities (pipelines, pump stations, and tanks)	R, S, MS	30%				60%		90%	X	
Control Systems										
SCADA or other control systems	R, S, MS				30%	60%	90%			
Distribution										
Critical Facilities										
Wholesale Users (other communities, rural water districts)	R, S, MS					60%		90%	X	
Hospitals, EOC, Police Station, Fire Stations	R, S, MS				60%	90%		X		
Emergency Housing										
Emergency Shelters	R, S, MS				60%	90%		X		
Housing/Neighborhoods										
Drink water available at community distribution centers	R, S, MS			30%	60%	90%		X		
Water for fire suppression at fire hydrants	R, S, MS				60%	90%			X	
Community Recovery Infrastructure										
All other clusters	R, S, MS						60%	90%		X

See footnotes on Table A-12, page 59.

Table A-30: Riverbend, USA wastewater infrastructure performance goals for extreme flood

Disturbance		
(1)	Hazard	Flood
	Hazard Level	Extreme
	Affected Area	Regional
	Disruption Level	Severe

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Extreme Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-36	36+
Treatment Plants										
Treatment plants operating with primary treatment and disinfection	R, S, MS				30%	60%		90%	X	
Treatment plants operating to meet regulatory requirements	R, S, MS								90%	X
Trunk Lines										
Backbone collection facilities (major trunkline, lift stations, siphons, relief mains, aerial crossings)	R, S, MS					30%	60%		90%	X
Flow equalization basins	R, S, MS					30%	60%		90%	X
Control Systems										
SCADA and other control systems	R, S, MS						60%		90%	X
Collection Lines										
Critical Facilities										
Hospitals, EOC, Police Station, Fire Stations	R, S, MS				30%	90%			X	
Emergency Housing										
Emergency Shelters	R, S, MS				30%	90%			X	
Housing/Neighborhoods										
Threats to public health and safety controlled by containing & routing raw sewage away from public	R, S, MS				30%	60%	90%		X	
Community Recovery Infrastructure										
All other clusters	R, S, MS						60%		90%	X

See footnotes on Table A-12, page 59.

Table A-31: Riverbend, USA communications infrastructure performance goals for extreme flood

Disturbance		
(1)	Hazard	Flood
	Hazard Level	Extreme
	Affected Area	Regional
	Disruption Level	Severe

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	(4) Support Needed	Overall Recovery Time for Hazard and Level Listed Extreme Hazard Level								
		Phase 1 – Short-Term			Phase 2 -- Intermediate			Phase 3 – Long-Term		
		Days			Wks			Mos		
		0	1	1-3	1-4	4-8	8-12	4	4-36	36+
Core and Communications Buildings										
Central Offices	R, S, MS, C	90%			X					
Buildings containing exchanges	R, S, MS, C	90%			X					
Distribution Hubs										
Free standing cell phone towers	R, S, MS, C		90%		X					
Last Mile										
Critical Facilities										
Hospitals	R, S, MS, C	90%			X					
Police and fire stations	R, S, MS, C	90%			X					
Emergency operation center	R, S, MS, C	90%			X					
Emergency Housing										
Residences	R, S, MS, C			30%	90%			X		
Emergency responder housing	R, S, MS, C			30%	90%			X		
Public shelters	R, S, MS, C			30%	90%			X		
Housing/Neighborhoods										
Essential city service facilities	R, S, MS, C			30%	60%	90%		X		
Schools	R, S, MS, C			30%	60%	90%		X		
Medical provider offices	R, S, MS, C			30%	60%	90%		X		
Retail	R, S, MS, C			30%	60%	90%		X		
Community Recovery Infrastructure										
Residences	R, S, MS, C			30%	60%	90%			X	
Neighborhood retail	R, S, MS, C			30%	60%	90%			X	
Offices and work places	R, S, MS, C			30%	60%	90%			X	
Non-emergency city services	R, S, MS, C			30%	60%	90%			X	
Businesses	R, S, MS, C			30%	60%	90%			X	

See footnotes on Table A-12, page 59.

Table A-32: Riverbend, USA summary resilience matrix for extreme flood

Disturbance		
(1)	Hazard	Flood
	Hazard Level	Extreme
	Affected Area	Regional
	Disruption Level	Severe

Restoration Levels		
(2)	30%	Restored
	60%	Restored
	90%	Restored
(3)	X	Current or At Goal

Functional Category: Cluster	**Overall Recovery Time for Hazard and Level Listed Extreme Hazard Level**								
	Phase 1 – Short-Term			**Phase 1 – Short-Term**			**Phase 1 – Short-Term**		
	Days	**Days**	**Days**	**Wks**	**Wks**	**Wks**	**Mos**	**Mos**	**Mos**
	0	**1**	**1-3**	**1-4**	**4-8**	**8-12**	**4**	**4-36**	**36+**
Critical Facilities									
Buildings						90%			X
Transportation			90%		X				
Energy				90%					
Water							90%	X	
Waste Water					90%			X	
Communication	90%			X					
Emergency Housing									
Buildings						90%			X
Transportation				90%		X			
Energy				90%					
Water					90%		X		
Waste Water					90%			X	
Communication				90%			X		
Housing/Neighborhoods									
Buildings							90%		X
Transportation				90%		X			
Energy				90%	X				
Water					90%			X	
Waste Water						90%		X	
Communication					90%		X		
Community Recovery									
Buildings								90%	X
Transportation				90%		X			
Energy				90%	X				
Water							90%		X
Waste Water								90%	X
Communication					90%			X	

See footnotes on Table A-12, page 59.

References

Brault, M.W. 2012. "Americans with Disabilities: 2010, Household Economic Studies." U.S. Census Bureau, Washington, DC. http://www.census.gov/prod/2012pubs/p70-131.pdf.